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North and Central American Species of *Aneurus* Curtis (Hemiptera: Aradidae)

By Nicholas A. Kormilev[1]

Fifteen species of the genus *Aneurus* Curtis, 1825, have been recorded for North and Central America. In the present paper five additional species are described and a key to the 20 species is presented.

This study is based on specimens from the U.S. National Museum, Washington, D.C., and the American Museum of Natural History, New York, N.Y., loaned by Drs. Richard C. Froeschner and Peter Wygodzinsky, respectively; and information from types in the British Museum (Natural History) furnished by Dr. William J. Knight. To all these men I offer my sincere thanks.

Measurements in this paper were taken with a micromillimeter eyepiece; 25 units equal 1 mm. For convenience, the length of the abdomen was taken from the tip of scutellum to the tip of hypopygium in the male and to segment IX in the female.

There has been some confusion concerning the identity of the Florida species, *Aneurus politus* Say (1832, p. 31). The original description made no reference to the important shape of the hypopygium. On the basis of five specimens from Guatemala, Champion (1898, p. 115) gave a short redescription with two drawings (table 7; figs. 29, 29a) and remarked about a "small and transverse" hypopygium. Comparison of three Florida specimens with three Central

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American (Mexico and Guatemala) specimens found them to be superficially similar but specifically distinct. In addition to smaller differences, the shapes of the scutellum and hypopygium are quite different (cf. figs. 14 with 17, and 15 with 18); the proportions of the antennal segments do not coincide; and the production of the paratergites of the females differ (cf. figs. 16 and 19). Thus, it is evident that Champion's specimens probably were not *politus* but an unnamed species that will be described below as *championi*.

To establish this usage and avoid further confusion, a neotype for *politus* will be proposed and described under the specific treatment of that taxon.

Key to North and Central American Species of *Aneurus*

Clavus fully developed, reaching tip of scutellum; latter triangular with pointed apex . . . . . Subgenus **Aneurosoma** Champion, 1898 (contains a single species, ***dissimilis*** (Bergroth), 1889)

Clavus greatly reduced to small triangle near basolateral angle of scutellum; apex of scutellum arcuate . . . . . Subgenus **Aneurus** Curtis, 1832

Subgenus *Aneurus*

1. Spiracles II to VII lateral, visible from above, VIII terminal. **vauriei** Kormilev, 1964, Jamaica, Guadeloupe

   At least spiracles III ventral or sublateral, not visible from above . . . 2

2. Spiracle III sublateral, placed close to border, though not visible from above. **nasutus** Kormilev, 1966, Guadeloupe

   Spiracle III ventral, placed far from border 3

3. Spiracles IV ventral, placed near border, not visible from above. 1. **pusillus,** new species, Guatemala, Panama

   Spiracles IV ventral, placed far from or close to border; when near border, spiracle V sublateral but not visible from above 4

4. Spiracle V lateral, visible from above 5

   Spiracle V ventral or sublateral, not visible from above 7

5. Scutellum longer, ratio between length and width at least 2:3 6

   Scutellum very short, ratio between length and width 1:2. **simplex** Uhler, 1871, northeastern U.S.

6. Smaller species, length less than 4.0 mm; anterior process of the head not reaching tip of antennal segment I; antennal segment II obovate. 2. **aibonitensis,** new species, Puerto Rico

   Larger species, length about 5.0 mm; anterior process of head produced beyond tip of antennal segment I; antennal segment II clavate. **septentrionalis** Walker, 1873, eastern Canada

7. Spiracle V sublateral, not visible from above. 3. **pisoniae,** new species, Puerto Rico

   Spiracle V ventral, placed far from border 8

8. Spiracle VI lateral, visible from above 9

   Spiracle VI ventral, not visible from above 14

9. Head longer than width across eyes (35:33); anterior process of the head slightly produced beyond tip of antennal segment I. **barberi** Kormilev 1960, St. Lucia (Lesser Antilles)

   Head as long or shorter than width across eyes; anterior process at most reaching as far as tip of antennal segment I 10

10. Head shorter than width across eyes (11:12).
pygmeus Kormilev, 1966, southern U.S.
Head as long as width across eyes 11
11. Antennal segment II clavate, as long as I; larger species, length over 4.0 mm 12
Antennal segment II obovate, shorter than I; smaller species, length less than 4.0 mm 13
12. Anterior process of the head reaching tip of antennal segment I; postocular tubercle (composed of 3 minute teeth) very short, not reaching to outer border of eyes . . . . . **haitiensis** Kormilev 1968, Haiti
Anterior process not reaching to tip of antennal segment I; postocular tubercles strong, acute, reaching outer border of eyes.
6. **championi**, new species, Guatemala, Mexico
13. Scutellum wider, ratio between length and width 11.5:19; lateral borders of abdomen finely serrate . . . . . 4. **froeschneri**, new species, Panama
Scutellum narrower, ratio between length and width 12:16; lateral borders of abdomen roughly serrate.
minutus Bergroth, 1886, southern U. S., Central America
14. Antennal segment II obovate, III and IV cylindrical 15
Antennal segment II clavate, III tapering toward base,. IV fusiform . 17
15. Scutellum subtriangular, rounded apically; ratio between length and width 10.5:19; hypopygium small, transverse (3.5:4).
tenuis Champion, 1898, Panama, Cuba?
Scutellum semicircular; ratio of length to width 2:3 or 3:4 16
16. Larger species, length over 5.0 mm; hypopygium long and wide (10.5:10).
montanus Champion, 1898, Guatemala
Smaller species, length less than 4.5 mm; hypopygium smaller (8:7).
fiskei Heidemann, 1904, U.S., Cuba?
17. Scutellum short, ratio of length to width 10:16 18
Scutellum longer, ratio of length to width 15:19 or 20:24.
7. **inconstans** Uhler, 1871, U.S.
18. Smaller species, length less than 4.0 mm; antennae shorter, less than twice as long as head is wide (24:12.5).
5. **politus** Say, 1832, southern U.S. (Florida)
Larger species, length over 5.0 mm; antennae longer, more than twice as long as head is wide (38:16).
leptocerus Hussey, 1957, Guatemala, Panama

1. *Aneurus pusillus*, new species

FIGURES 4–6

MALE.—Elongate, sides subparallel; minutely granulate. Head slightly shorter than width across eyes (♂ 10:11.5, ♀ 10.5:12). Anterior process conical, not reaching to tip of antennal segment I; jugae slightly visible from above. Antenniferous tubercles small, acute, convex exteriorly. Eyes large, semiglobose, protruding. Postocular tubercles conical with blunt tip, produced as far as, or a little less than, outer borders of eyes. Vertex very finely, transversely striate. Vertex mesad of eyes with two (1+1) large, ovate callosities. Antennae thin, one and one-half times as long as length of the head

(♂ 14:10, ♀ 15:10.5); segment I barrel shaped; II obovate, much smaller and narrower; III and IV cylindrical. Relative lengths of antennal segments I to IV: ♂ 3:3:2.5:5.5, ♀ 3.5:2.75:2.75:6. Labium very short, reaching middle of head.

Pronotum less than half as long as maximum width (♂ 9:19.5, ♀ 8.5:20). Collar tiny, sinuate in front. Anterolateral angles evenly rounded, produced neither forward, nor sideways. Lateral borders of forelobe parallel; humeri parallel, strongly converging anteriorly. Hind border sinuate in the middle. Foredisc with two (1+1) bean-shaped callosities, and a few small callosities laterad. Hind disc extremely finely punctured, with an arcuate, slightly raised, transverse, longitudinally striate strip.

Scutellum almost as long as basal width (♂ 10:11, ♀ 10:11), evenly arcuate apically; disc finely, concentrically striate.

Hemelytra reaching to the middle of tergum VII in both sexes; corium extended along basal third of scutellum.

Abdomen elongate ovate, longer than maximum width across segment IV (♂ 40.5:25, ♀ 40.5:25). Connexivum narrow; PE-angles not protruding; PE-VII rounded in the male, angularly rounded in the female. Paratergites (♂) moderately large, subtruncate apically, reaching apical fourth of hypopygium; latter moderately large, as long as maximum width (5:5). Paratergites (♀) triangular, very short, produced almost as far as segment IX; latter truncate posteriorly. Spiracles II lateral, III ventral, IV ventral placed nearer to border, V to VII lateral, VIII terminal.

COLOR.—Yellow brown or pale testaceous, partially testaceous.

MEASUREMENTS.—Total length: ♂ 2.85, ♀ 2.85 mm; width of pronotum: ♂ 0.78, ♀ 0.80 mm; width of abdomen: ♂ 1.00, ♀ 1.00 mm.

HOLOTYPE.—♂, Guatemala, Cacao, Trece Aguas, Alta v. Paz; Schwarz and Barber coll. (USNM type 69794).

ALLOTYPE.—♀, collected with holotype; in the same collection.

PARATYPES.—2 ♂♂ and 4 ♀♀, Panama, C.Z., Bohio; Schwarz coll., 6–9.II.; 1 ♀, Porto Bello; Schwarz coll., 26.II; in the same and Kormilev collections.

REMARKS.—*Aneurus pusillus* is the smallest known American species of *Aneurus*. It belongs to the group with evenly rounded scutellum and relatively large hypopygium. Its relation to other species is seen from the key.

2. *Aneurus aibonitensis*, new species

FIGURES 7, 8

FEMALE.—Elongate ovate; head, pronotum, and lateral borders of abdomen, densely and relatively roughly punctured; lateral borders of pronotum finely serrate.

Head shorter than width across eyes (11.5:13). Anterior process conical; jugae slightly shorter than clypeus, their tips still visible from above; tip rounded, reaching to apical fourth of antennal segment I. Antenniferous tubercles short, acute, divergent. Eyes large, semiglobose, protruding. Postocular tubercles strong, dentiform, acute, with minuscule serrations on the foreborder. Vertex transversely rugose, with two (1+1) large, ovate callosities mesad of eyes. Antennae moderately robust, twice as long as head (21.5:11.5); antennal segment I obovate, thick; II obovate, but half as thick as I; III and IV subcylindrical, very slightly tapering toward the base. Relative lengths of antennal segments I to IV: 4:4:4.5:9. Labium short, reaching line connecting hind borders of eyes.

Pronotum less than half as long as maximum width (12.5:27.5). Collar very thin, feebly sinuate in front. Anterior borders truncate; anterolateral angles angularly rounded, produced neither forward, nor sideways; lateral borders of forelobe straight, convergent; lateral borders of hind lobe slightly convex; both finely, but distinctly serrate. Hind border sinuate in the middle, convex laterally. Foredisc with four (2+2) low callosities; hind disc densely punctured and transversely striate along posterior border laterally.

Scutellum semicircular, shorter than basal width (12.5:18); disc concentrically rugose.

Hemelytra reaching slightly over foreborder of tergum VII; corium very short, reaching basal one-fourth of scutellum; membrane densely and deeply punctured.

Abdomen elongate ovate, longer than maximum width across segment IV. Connexivum moderately wide; connexiva III to V twice as long as wide; exterior borders slightly raised, densely granulate; mesad of granulation obliquely rugose around callosities. Tergum VIII roughly, obliquely rugose. Paratergites very short, serrate, reaching middle of segment IX; latter subtruncate, slightly sinuate in the middle of posterior border. Spiracles II and V to VII lateral and visible from above, III and IV ventral and placed far from border, VIII terminal.

COLOR.—Reddish brown; membrane darker, with pale, opaque, basolateral border.

MEASUREMENTS.—Total length 3.70 mm, width of pronotum 1.10 mm, width of abdomen 1.40 mm.

HOLOTYPE.—♀, Puerto Rico, Aibonito BF, Medina coll., VI.1961 (USNM type 69795).

REMARKS.—*Aneurus aibonitensis*, new species, is related to *A. fiskei* Heidemann, 1904, but is smaller, narrower, and with different position of spiracles.

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3. *Aneurus pisoniae*, new species

FIGURES 9–11

MALE.—Elongate ovate.

Head shorter than width across eyes (♂ 12.5:14, ♀ 13:15). Anterior process conical with rounded tip; reaching apical fifth of antennal segment I; jugae not visible from above. Antenniferous tubercles short, subtruncate anteriorly, blunt. Eyes moderately large, protruding. Postocular tubercles blunt, with minute granulation, short, not approaching outer borders of eyes. Vertex roughly, transversely rugose, with two (1+1) large, ovate callosities placed mesad of eyes. Antennae moderately thin; antennal segment I obovate, robust; II also obovate, but much narrower; III and IV subcylindrical, slightly tapering toward base. Relative lengths of antennal segments I to IV: ♂ 4.5:4:5:10, ♀ 5:4.5:5.25:10.5. Labium reaching line connecting the middles of eyes.

Pronotum less than half as long as maximum width (♂ 12.5:29, ♀ 14:31). Collar thin, sinuate in front. Anterior borders straight, slightly oblique; anterolateral angles rounded and slightly produced forward beyond collar; lateral borders of forelobe straight, converging; lateral borders of hindlobe subparallel, convergent, rounded anteriorly. Hindborder sinuate in the middle, convex laterally. Foredisc with two (1+1) bean-shaped callosities and a few callous rugae laterad of them. Hind disc finely, transversely striate anteriorly; very finely, longitudinally striate posteriorly.

Scutellum subtriangular; lateral borders moderately convex, apex angularly rounded. Scutellum shorter than basal width (♂ 12.5:19, ♀ 12.5:20). Disc concentrically rugose along the borders; longitudinally rugose in the middle.

Hemelytra reaching to the middle of tergum VII in both sexes; corium reaching basal fourth of scutellum.

Abdomen ovate in both sexes, longer than wide (♂ 53:38.5, ♀ 58:42.5). Connexivum moderately wide; segments IV to VI twice as long as wide. Exterior borders of connexiva slightly raised, granulate; disc around callosities sparsely rugose. Paratergites (♂) short, rounded, reaching apical fourth of hypopygium; latter small, shorter than its maximum width (5:6). Paratergites (♀) short, forming an obtuse angle, their interior border twice as long as exterior, produced as far as segment IX; latter truncate posteriorly. Spiracles II and VI to VII lateral and visible from above, III to IV ventral, V placed close to border but not visible from above, VIII terminal.

COLOR.—Head, pronotum, and scutellum yellow brown; connexivum brown; membrane black; ventral side ochraceous medially, yellow brown laterally.

MEASUREMENTS.—Total length: ♂ 3.70, ♀ 4.00 mm; width of pronotum: ♂ 1.16, ♀ 1.24 mm; width of abdomen: ♂ 1.54, ♀ 1.70 mm.

HOLOTYPE.—♂, Puerto Rico, Maricao; De Leon coll., 16.IV.1940, on *Pisonia subcordata* (USNM type 69796).

ALLOTYPE.—♀, collected with holotype; in the same collection.

PARATYPES.—4 ♂♂ and 2 ♀♀, collected with holotype; in the same and Kormilev collections.

REMARKS.—*Aneurus pisoniae*, new species, is related to *A. haitiensis* Kormilev (1968, p. 2), but is smaller, with lateral borders of forelobe of pronotum straight, hypopygium more narrowly rounded, paratergites shorter, and color more contrasting: yellow brown with black membrane.

4. *Aneurus froeschneri*, new species

FIGURES 12, 13

FEMALE.—Elongate ovate, finely granulate.

Head slightly shorter than width across the eyes (12.5:13). Anterior process conical, rounded apically, reaching to tip of antennal segment I; jugae reaching almost to tip of clypeus, clearly visible from above. Antenniferous tubercles small, acute, convex exteriorly, and slightly divergent. Eyes moderately large, protruding. Postocular tubercles strong, dentiform, acute, reaching as far as outer margins of eyes. Vertex finely, transversely rugose, with two (1+1) large, ovate callosities mesad of eyes. Antennae slender, less than twice as long as head (20.25:12.5); antennal segment I stout, obovate; II narrowly obovate; III and IV cylindrical; relative lengths of antennal segments I to IV: 4:3.75:3.75:8.75. Labium reaching line connecting middles of eyes.

Pronotum less than half as long as maximum width (11.5:27). Collar thin, sinuate in front. Anterolateral angles rounded, produced forward beyond collar; lateral borders of forelobe together with lateral notch slightly sinuate; lateral borders of hind lobe slightly convex, converging anteriorly; both finely serrate, particularly in the lateral notch. Hind border sinuate medially, angularly produced laterally. Foredisc with two (1+1) large ovate callosities, and granulate laterad of them. Hind disc very finely granulate anteriorly and medially; very finely, transversely striate along posterior border laterally.

Scutellum shorter than basal width (11.5:19); lateral borders weakly convex, apex evenly rounded.

Hemelytra reaching almost to hind border to tergum VII. Corium reaching basal third of scutellum; membrane densely and roughly punctured.

Abdomen elongate ovate, longer than maximum width across segment IV (53:38). Connexivum moderately wide. Paratergites small, rounded, reaching as far as segment IX; latter truncate posteriorly. Spiracles II and VI to VII lateral and visible from above, III to V ventral and placed far from border, VIII terminal.

COLOR.—Dark yellow brown; connexivum brown; membrane dark brown.

MEASUREMENTS.—Total length 3.64 mm, width of pronotum 1.08 mm, width of abdomen 1.52 mm.

HOLOTYPE.—♀, Panama, El Valle; N.L.H. Krauss coll., XI.1946 (USNM type 69797).

REMARKS.—It is a pleasure to name this species for Dr. Richard C. Froeschner, by whose kind offices I have had an opportunity to study this lot as well as many other Aradidae from the collections in his charge.

Aneurus froeschneri, new species, is related to *A. minutus* Bergroth, 1886, from which it differs as indicated in the key.

5. *Aneurus politus* Say

FIGURES 14–16

Aneurus politus Say, 1832, p. 31.

MALE.—Elongate ovate; shiny.

Head as long as width across eyes (♂ 12.5:12.5, ♀ 15:15). Anterior process conical, rounded anteriorly, reaching slightly beyond the tip of antennal segment I; jugae adherent to clypeus, not visible from above. Antenniferous tubercles short, truncate anteriorly, not acute. Eyes moderately large, protruding. Postocular tubercles stout, dentiform, blunt, produced as far as lateral margins of eyes. Vertex transversely rugose, with two (1+1) moderately large, ovate callosities mesad of eyes. Antennae almost twice as long as head (♂ 24:12.5, ♀ 29.5:15); antennal segment I barrel shaped; II and III clavate; IV elongate fusiform; relative lengths of antennal segments I to IV: ♂ 3.5:5:5.5:10, ♀ 4:6.5:7.5:11.5. Labium reaching line connecting hind borders of eyes.

Pronotum less than half as long as maximum width (♂ 10:25, ♀ 12.5:30). Anterior borders straight, slightly oblique; anterolateral angles rounded, slightly produced beyond collar; lateral borders of forelobe together with lateral notch moderately sinuate; lateral borders of hind lobe slightly convex, strongly converging anteriorly; hind border sinuate, medially. Foredisc with four (2+2) large, ovate, blurred callosities. Hind disc very finely, transversely striate anteriorly and along hind border laterally; shiny in the middle.

Scutellum transverse, much shorter than basal width (♂ 10:16.5, ♀ 11:20); tip widely arcuate. Disc with an elongate callous spot

in the middle anteriorly; concentrically striate around callosity.

Hemelytra reaching to the middle of tergum VII; corium reaching basal third of scutellum; membrane finely punctured, finely wrinkled around punctures; exterior border of membrane smooth, transparent.

Abdomen longer than maximum width across segment IV (♂ 55:37.5, ♀ 60:56). Connexivum moderately wide. Paratergites (♂) long, subtriangular, rounded apically, reaching apical fourth of hypopygium; latter large, elongate, rounded at base and apically (10:8). Paratergites (♀) large, rounded apically, produced far beyond small and short segment IX, latter slightly sinuate posteriorly. Spiracles II and VII lateral, visible from above; III to VI ventral, placed far from border; VIII terminal.

COLOR.—Reddish brown; forelobe of pronotum, tergum, prosternum, meso- and metasternum around coxae, pale yellow brown; membrane brown.

MEASUREMENTS.—Total length: ♂ 3.60, ♀ 4.20 mm; width of pronotum: ♂ 1.00, ♀ 1.20 mm; width of abdomen: ♂ 1.50, ♀ 2.24 mm.

NEOTYPE.—♂, U.S.A., Florida, Biscayne; 21.V.1887, ex Uhler collection (USNM type 69798).

EXAMINED SPECIMENS.—1 ♀, Florida, Biscayne; 26.V.1887, ex Uhler collection (USNM). 1 ♀, Florida, Belle Air; ex collections of Mrs. A. T. Slosson (AMNH).

6. *Aneurus championi*, new species

FIGURES 17–19

FEMALE.—Elongate ovate, shiny.

Head almost as long as width across eyes (♀ 15.5:16, ♂ 15:14.5). Anterior process conical, reaching three-fourths of antennal segment I; tips of jugae slightly visible from above. Antenniferous tubercles acute exteriorly, slightly divergent. Eyes semiglobose, protruding. Postocular tubercles dentiform, acute, slightly produced beyond outer border of eyes (♀), or reaching to latter (♂). Infraocular, ovate, callous spots large. Vertex transversely rugose. Antennae slender, less than twice as long as head (♀ 27.5:15.5, ♂ 24.5:15); antennal segment I obovate; II clavate; III subcylindrical, tapering toward base; IV cylindrical; relative lengths of antennal segments I to IV: ♀ 5.5:5.5:5.5:11, ♂ 5:5:5:10.5. Labium reaching line connecting hind borders of eyes.

Pronotum less than half as long as its maximum width (♀ 15:34, ♂ 12.5:30). Collar sinuate. Anterolateral angles rounded, very slightly produced forward beyond collar. Lateral borders parallel at humeri, strongly convergent and sinuate anteriorly. Hind border sinuate in the middle. Foredisc with two (1+1) bean-shaped calloused spots and with a few semifused callosities laterad of them; granulate

in front of callosities. Hind disc finely longitudinally striate, with exception of two (1+1) transverse, glabrous spots.

Scutellum subtriangular with subtruncate or widely arcuate apex. Disc concentrically rugose around mediobasal longitudinal rugae.

Hemelytra reaching middle of tergum VII (♀), or hind border of tergum VI (♂).

Abdomen longer than its maximum width across segment IV (♀ 69:50, ♂ 60:46). Connexivum relatively wide; PE-angles barely protruding. Tergum VIII (♀) small, narrower than head (12:16). Segment IX more than one-third width of head (6:16); paratergites rounded, reaching segment IX. In male, paratergites small, divergent, produced beyond small, transverse hypopygium; the latter much shorter than wide (3:5). Spiracles: II, VI, and VII lateral and visible from above; III and IV ventral and placed far from border; VIII terminal.

COLOR.—Yellow brown, venter paler; membrane infuscate; labium and tarsi yellow.

MEASUREMENTS.—Total length: ♀ 4.68; ♂ 3.90 mm; width of pronotum: ♀ 1.36, ♂ 1.20 mm; width of abdomen: ♀ 2.00, ♂ 1.84 mm.

HOLOTYPE.—♀, Guatemala, Chicacao; E. J. Hambleton coll., 7.VII.1945 (USNM type 69799).

ALLOTYPE.—♂, Mexico, Vera Cruz, Peñuela; H. Dybas coll., 17.VII.1941; deposited in the Field Museum of Natural History, Chicago.

PARATYPES.—2 ♀♀ and 1 ♂, collected with allotype; in the Field Museum of Natural History, Chicago, and Kormilev collection.

REMARKS.—This species is named for the eminent British entomologist, G. C. Champion, who did the first comprehensive survey of Central American Aradidae.

7. *Aneurus inconstans* Uhler

FIGURES 1–3

Aneurus inconstans Uhler, 1871, p. 105.

In the collections examined, this species was sometimes confused with *A. septentrionalis* Walker. The key given earlier plus the three drawings will permit ready separation of the two forms.

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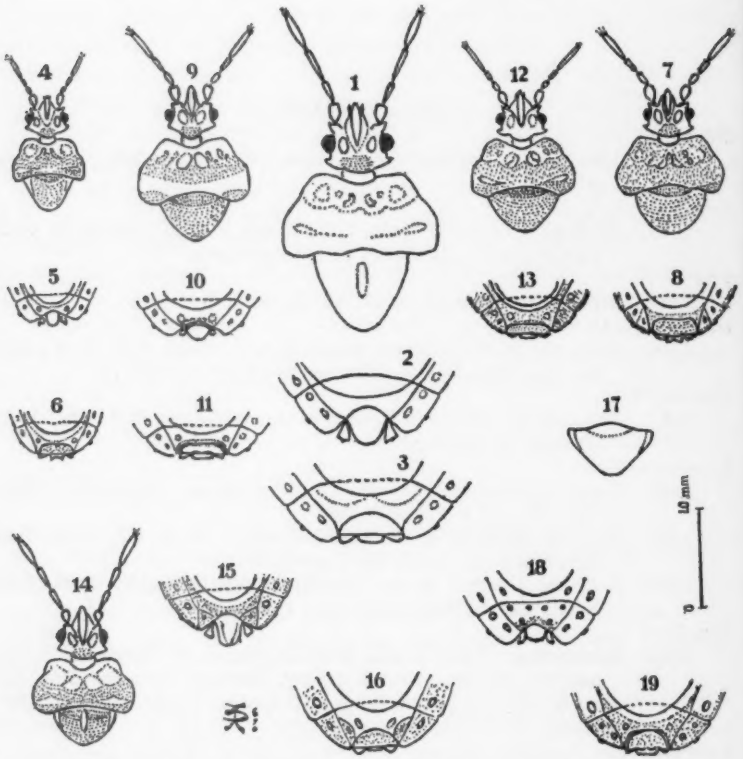

FIGURES 1–19.—*Aneurus inconstans* Uhler 1871: 1, head, pronotum, and scutellum, ♂; 2, apex of abdomen from above, ♂; 3, same, ♀. *Aneurus pusillus*, new species: 4, head pronotum, and scutellum, ♂; 5, apex of abdomen from above, ♂; 6, same, ♀. *Aneurus aibonitensis*, new species: 7, head, pronotum, and scutellum, ♀; 8, apex of abdomen from above, ♀. *Aneurus pisoniae*, new species: 9, head, pronotum, and scutellum, ♂; 10, apex of abdomen from above, ♂; 11, same, ♀. *Aneurus froeschneri*, new species: 12, head, pronotum, and scutellum, ♀; 13, apex of abdomen from above, ♀. *Aneurus politus* Say 1832: 14, head, pronotum, and scutellum, ♂; 15, apex of abdomen from above, ♂; 16, same, ♀. *Aneurus championi*, new species: 17, scutellum, ♂; 18, apex of abdomen from above, ♂; 19, same, ♀.

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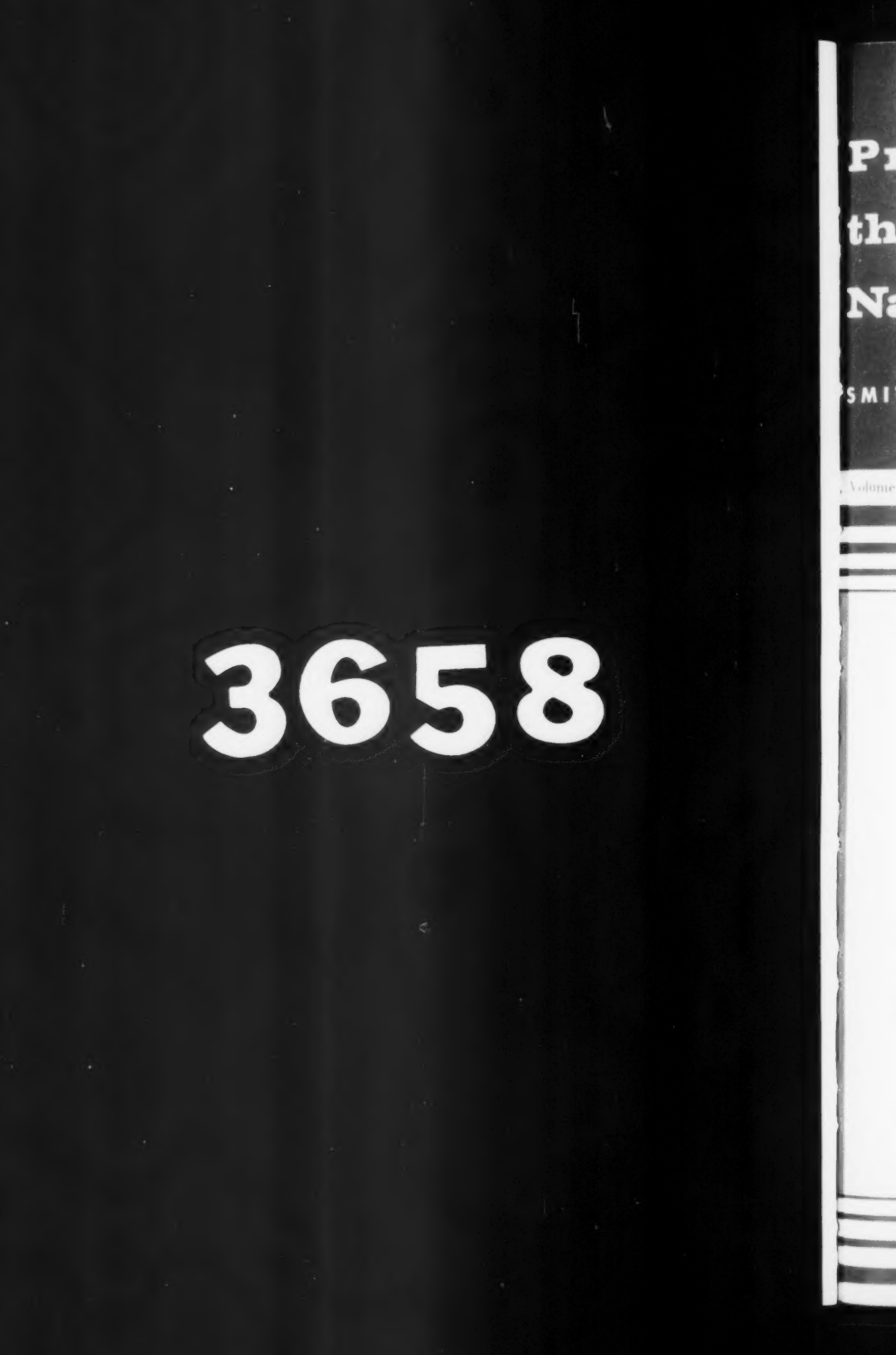
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Interspecific Competition in the Tropical Rain Forest: Ecological Distribution Among Lizards at Belém, Pará

By A. Stanley Rand and Stephen S. Humphrey[1]

The ecological differences between sympatric species have proved useful foci for ecological studies, particularly those with an evolutionary viewpoint. The information provided by such studies is relevant to considerations of interspecific competition and to the problem of the causes of tropical species diversity. In general, it is assumed that a species' closest competitors in an area are its nearest relatives. This is probably true within generic and specific groups, but, as this study suggests, it may not be true for higher categories.

Studies on the ecology of sympatric lizards (usually restricted to sympatric congeners) have been made at several localities by various workers, among them Milstead (1957), Inger (1959), Collette (1961), Rand (1964). Little has been published about the ecology of the lizards of lowland tropical forests and almost nothing about those in the rain forests of the Amazon. The study most comparable to the present one is that of Sexton, Heatwole, and Knight (1964) in Panama.

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As a result of the observations made in conjunction with other field studies, the authors have collected considerable information about the natural history of lizards in the vicinity of Belém, Pará, Brazil. Some of this has already been published (Rand, 1965; Rand and Rand, 1966), and additional papers are planned. In this paper we present our data on microdistribution patterns among the common diurnal lizard species and its relevance to possible interspecific competition among lizards. We also present our data on lizard body temperature and their relation to habitat distribution.

The senior author, who has made four trips to Belém, has spent a cumulative total of almost four months there between 1963 and 1966. These visits were all made during the period of May through August, a time of intermediate rainfall. The junior author visited Belém from July through August, 1964, and from June through August, 1965.

The observations reported herein were made in the vicinity of the city of Belém, Pará, at lat. 1°27′S, long. 48°30′W, altitude less than 100 feet. The climate is hot tropical with abundant rain and a marked but not severe or prolonged dry season in the southern winter. The climax vegetation is forest, of which three types are locally recognized: "mata de terra firme" or upland forest; "varzea" or forest that is flooded daily by the freshwater tides; and "igapo" or permanently flooded swamp forest (Ducke and Black, 1953). We were able to sample the first two forests much more adequately than the latter.

In addition to the above, we visited a variety of sites that had been disturbed by man and were in various stages of regeneration—from scattered bunches of grass and bare ground to old second growth.

The main localities where our observations were made are as follows:

Parque do Museu Goeldi – a small patch of forest in the city, the undergrowth much modified and denser than normal because of edge effect in some places, cleaned out in others, but the canopy only slightly disturbed.

Bosque Municipal – a somewhat larger but still small patch of forest in the city, modified in much the same way as the Parque do Museu, but less so.

Utinga and Agua Preta – localities in the preserve around the city water supply on the edge of the city, which include "mata de terra firme," selectively cut but quite good in places, and various ages of second growth from just abandoned "roças" through dense tangles to forest that betrays its second growth nature only in the species composition.

IPEAN and Guama Forest Reserve – localities of "mata de terra firme," "varzea" and some "igapo" forest. A variety of ages of

second growth and agricultural situations also were sampled in this area.

The following species were seen frequently enough to provide some idea of habitat distribution: *Gonatodes humeralis*, *Iguana iguana*, *Tropidurus torquatus*, *Plica umbra*, *Uranoscodon superciliosa*, *Polychrus marmoratus*, *Anolis punctatus*, *Anolis fuscoauratus*, *Cnemidophorus lemniscatus*, *Ameiva ameiva*, *Kentropyx calcaratus*, *Tupinambis nigropunctatus*, *Mabuya mabuya*. All are diurnal and together these species include over 99 percent of all the lizards we saw active during the day.

Two geckos, *Hemidactylus mabouia* and *Thecadactylus rapicaudus*, the first a common species, are omitted because they are nocturnal. Also seen only rarely were *Anolis ortoni*, *Amphisbaena alba*, *Crocodilurus lacertinus*, and several microteiids.

We must thank Dr. Dalcy Albuquerque, Director of the Museu Paraense "Emilio Goeldi," and Dr. Robert Shope, then Director of the Belém Virus Laboratory, for their help during our visits to Belém.

We are much indebted to Dr. P. Humphrey of the University of Kansas and Dr. P. Vanzolini of the Departamento de Zoologia, São Paulo, for their field assistance and encouragement and for arranging support for the field work of the junior and senior authors, respectively. We also wish to thank the directors of the Instituto de Pesquisas Experimentacão Agropecuarias do Norte (IPEAN) and the Belém Virus Laboratory for their many courtesies and assistance.

SPHAERODACTYLIDAE

Gonatodes humeralis

HABITAT.—Found only in the forest and in old second growth in the "mata de terra firme" and, less commonly, in the "varzea." They were not found in the young second growth or in open areas without a closed canopy.

These geckos perch above the ground on the trunks of small to very large trees, on large logs and stumps. They are almost always within one and one-half meters of the ground. Rarely were they seen on twigs or leaves or in small bushes, but most frequently on buttressed trees, trees with loose bark, or many small branches or suckers against the trunk that provide complex hiding places, but they are not restricted to such trees. They may leave a perch to hide in leaves on the ground and sometimes come to the ground to catch food.

ABUNDANCE.—This is the most frequently seen lizard in the forest and probably the most abundant. It was most common in the somewhat

disturbed areas (Bosque and Parque), where densities of several per 100 square meters were probably reached. In the less disturbed and more extensive forests they were much less common. Usually a single lizard was seen on a tree, occasionally two (a male and female), but seldom more.

FOOD.—Insects and other small invertebrates.

TEMPERATURE.—Probably a nonheliotherm, it was never seen basking, but no temperatures were taken.

IGUANIDAE

Iguana iguana

HABITAT.—Very few of these large lizards were seen but they are reported to be most common along the edges of the rivers. One was seen on the edge of a large clearing. It is quite possible that they live in the canopy of the forest away from clearings and rivers as well as on edges, but they are very difficult to see in such situations. They did well in the forested Parque do Museu Goeldi.

In most forested localities (Panama, Swanson, 1950; Costa Rica, Hirth, 1963; British Honduras, Neill and Allen, 1959), iguanas are highly arboreal lizards as adults, though one occasionally comes to the ground. The juveniles are reported as living closer to the ground. Apparently this is true around Belém for local men who hunt them say that they live on the branches of trees. Those running loose in the Museu Goeldi Parque were seen usually 10–20 meters up in the larger trees.

ABUNDANCE.—We saw them rarely, even when we were examining the river margin. Due to hunting they are probably very shy.

FOOD.—Primarily herbivorous and probably largely eat leaves.

TEMPERATURE.—A heliotherm (McGinnis and Brown, 1966). No temperatures were taken but iguanas in the Parque do Museu Goeldi were seen frequently basking.

Tropidurus torquatus

HABITAT.—Found only in open areas and along the edges of clearings, and not in dense second growth or forest.

These lizards perch above the ground, usually below two meters, on tree trunks, logs, rocks, walls, stumps, etc. They seldom climb above three meters except when frightened and are very rarely seen in bushes, on twigs, leaves, etc. They frequently come to the ground to feed.

ABUNDANCE.—This is the most frequently seen lizard in the open and probably the most common. Only one adult male is seen per perch but sometimes one or two females and several juveniles may be associated with him.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A heliotherm (fig. 2). It frequently basks and shows difference in posture related to substrate temperatures. (For more detailed data on this species, see Rand and Rand, 1966.)

Plica umbra

HABITAT.—Found only in the forest and older second growth. These lizards occur in the "mata de terra firme" and, at least occasionally, in the "varzea" and are not found in the open or on isolated trees.

Individuals of *Plica umbra* were seen on the trunks and branches of moderate to large trees from close to the ground up to at least several meters. None were seen in bushes or on twigs.

FOOD.—Insects and other invertebrates.

ABUNDANCE.—Moderately common. Seldom were two seen on the same perch, but several times a male and a female were found only a few meters apart, more frequently than we would have expected by chance alone. Perhaps some sort of pair bond is formed.

TEMPERATURE.—A nonheliotherm (fig. 2). No basking behavior was seen.

Uranoscodon superciliosa

HABITAT.—Found only along the shaded margins of streams and lakes where the forest interior comes to the edge of the water in both "mata de terra firme" and "varzea."

Individuals were seen up to two meters high on moderate to large diameter tree trunks and on logs at the edge or in the water, some of which the lizards could have reached only by swimming. They frequently jumped into the water when approached and sometimes dove to the bottom and hid.

ABUNDANCE.—This species is moderately common in its habitat. No more than one individual was seen on a perch.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A nonheliotherm (fig. 2). No basking behavior was seen.

Polychrus marmoratus

HABITAT.—An animal collector for the Belém Virus Laboratory took large numbers in second growth along the edges of forest. Our few specimens were found in similar places. It is likely that this species also occurs in the crown of the forest, as Rand has seen it in such habitats in Trinidad.

Polychrus can and does climb easily on small twigs and branches.

ABUNDANCE.—Though we saw few individuals, many were taken in the area by the Virus Laboratory collector.

FOOD.—Insects and other invertebrates plus an appreciable amount of plant material.

TEMPERATURE.—Probably a heliotherm (fig. 2).

Anolis punctatus

HABITAT.—In the forest, found in "mata de terra firme" and older second growth; not in "varzea" though this lizard probably occurs there at least occasionally. It was not found in the open, on isolated trees, or in young second growth.

Individuals were seen most commonly on the trunks and branches of moderate to large trees up to four meters. They probably also climb up into the branches and lower crown. One individual was seen once coming to the ground to catch something.

ABUNDANCE.—This is a moderately abundant species; usually single individuals were found, occasionally a male and female were found on the same perch or adjacent perches.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A nonheliotherm (fig. 2). No basking behavior was seen.

Anolis fuscoauratus

HABITAT.—In the "mata de terra firme," in old second growth and at least edge of "varzea," and not in the open areas on isolated trees or bushes, nor in young second growth.

Individuals were seen sometimes on tree trunks but somewhat more frequently on bushes and slender twigs close to the ground; they were found usually below two meters but occasionally as high as three or four, and also they were seen on the leaf litter on the ground.

ABUNDANCE.—Moderately common. Usually isolated individuals were found, but once a male and tiny juvenile were found on the same tree. There is some suggestion that they group themselves in loose colonies with adjacent home ranges rather than distributing themselves evenly or randomly over the available habitat.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A nonheliotherm (fig. 2). No basking behavior was seen.

TEIIDAE

Cnemidophorus lemniscatus

HABITAT.—Found in open areas where the vegetation is so sparse that there is bare, unshaded ground exposed between tussocks of grass or bushes and not in the forest or even young second growth. The juveniles seem to occur in the most open parts of the habitat.

The species is terrestrial though individuals occasionally climb short distances up bushes or onto logs and hide in holes in the ground.

ABUNDANCE.—Occurring in only a few places but abundant there.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A heliotherm (fig. 2). Individuals were seen basking and were active only in the heat of the day on sunny days.

Ameiva ameiva

HABITAT.—Primarily along edges of clearings in forest and second growth. It ranges out into open areas but seldom far from bushes and other cover, and also into second growth and forest but seldom more than a few meters from an edge. Ameivas turn up in clearings completely surrounded by forest, indicating that they do disperse through the forest.

Ameivas are terrestrial, occasionally climbing on rocks and logs, hiding in holes in the ground and among rocks.

ABUNDANCE.—Widespread and common in edge and edificarian situations.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A heliotherm (fig. 2). Ameivas were seen basking; they are usually active only during the heat of the day and primarily on sunny days.

Kentropyx calcaratus

HABITAT.—Primarily in the forest, "mata de terra firme," old second growth, and high spots in the "varzea"; very occasionally individuals were seen in open areas.

Though terrestrial, they not uncommonly were seen climbing upon a log, the base of a tree, or branches of a fallen treetop. They hide in holes in the ground and under logs.

ABUNDANCE.—Widespread in the forest but only moderately common.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A heliotherm (fig. 2). Individuals were seen basking in sun patches on the forest floor; they were active only in the middle of the day and on sunny days.

Tupinambis nigropunctatus

HABITAT.—This seems to be a wide-ranging species, moving out into open areas, occurring in second growth and far inside the forest in "mata de terra firme" and "varzea."

Largely terrestrial, it hides in holes in the ground.

ABUNDANCE.—Not commonly seen but, because it is hunted, it is very shy.

FOOD.—A variety of animal prey including small vertebrates.

TEMPERATURE.—Probably a heliotherm, as several were seen basking (no temperature records).

SCINCIDAE

Mabuya mabouia

HABITAT.—Most common along the edges of forest and of second growth, it also occurs well inside the forest and out in open grassy situations where hiding places are available. With the possible exception of *Tupinambis*, this has the widest habitat range of all the species considered in this paper.

This species is partly terrestrial, but also it is seen frequently on logs, wood piles, and even short distances up tree trunks. It is one of the few species regularly seen in tall grass areas, where they are seen on tree trunks and on posts that extend above the grass.

ABUNDANCE.—Moderately common, least so inside the forest.

FOOD.—Insects and other invertebrates.

TEMPERATURE.—A heliotherm (fig. 2). Frequently seen basking.

Discussion

The ecological profile given in figure 1 summarizes the microdistributions of the lizards under consideration in the Belém area. No species ranges throughout the whole spectrum of the area though some species certainly are more widely distributed than are others.

Of the habitats studied, the forest is the richest in number of species, but most of the species there are not abundant—at least they are not commonly seen. Some of the species high in the forest canopy and others in the leaf litter are certainly more abundant than indicated by the number of times that we saw them. Restricting consideration to areas where our observations are best, among the species that live on tree trunks near the ground or are conspicuously active on the ground, most of the species in the relatively undisturbed forest seem rarer than those outside it. The localities where most of the forest species were most common—the Parque do Museu and the Bosque Municipal—were places where the canopy was only slightly disturbed but the understory more so and where many things, particularly certain snakes, birds, and mammals that might be predators or competitors, were probably absent.

In the forest habitats not only density of individuals per species, but also total density of individuals of all lizard species taken together seemed less than in some more disturbed areas.

Second growth has a lizard fauna much like that of the forest except that certain species are missing and a few like *Ameiva* are more com-

mon. Canopy species, particularly *Polychrus marmoratus*, are seen here, more frequently than in older forest apparently because the canopy is closer to the ground.

Clearings and edges have few species but they are sometimes extremely abundant, particularly *Tropidurus torquatus*. These species are undoubtedly native in areas such as Belém, where rain forest is the climax vegetation, but they also occur in other major habitat areas such as "cerrado," where rain forest is absent. Though the lizards typical of clearings disperse through and even live inside the rain forest (e.g., *Mabuya*), they are never abundant there.

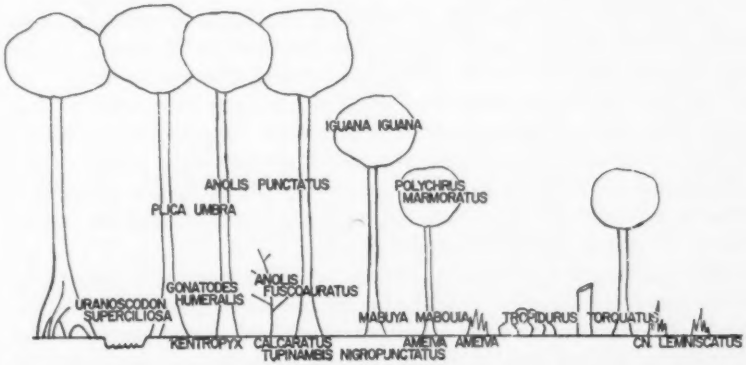

FIGURE 1.—Habitat distribution in Belém lizards: Schematic cross section of Belém habitats from upland forest, with a small forest stream at left, through second growth and grassland to bare ground at right (each species located in area of maximum observed abundance).

There are a number of factors that may be involved in making the forest the environment where the largest number of species occur. Of the environments in the Belém region, the forest comprises the greatest area, it is the most stable on any one site, and it contains the widest floristic diversity and probably the most numerous species of other animals. (These factors were all certainly true before the advent of modern man.) All of these may well be involved in promoting species diversity, and this paper provides no evidence for emphasizing or excluding any of them. Figure 1 suggests that the greater structural complexity of the forest may also be important. There are lizards in the forest occupying structural situations that do not exist or exist only rarely outside the forest. Their restriction to the forest may be, in part, the direct result of the fact that the forest's more complex structuring provides places for the lizards to live.

The physical structures in an environment that a lizard uses as lookouts, hiding places, basking spots, etc., form an important aspect of the

environment from the lizard's point of view. They have been called the lizard's "structural niche" (Rand, 1964). When the term was proposed for West Indian anoles, it was found that certain measurements of the perches on which the lizards were seen provided a useful description. Though the concept of structural niche seems useful for Belém lizards, measurements used for West Indian anoles are not sufficient and other environmental parameters must also be considered. In the case of *Uranoscodon superciliosa*, the proximity of water seems important. No system of quantifying the various aspects of structural niches was devised, and they have been described verbally in the foregoing species accounts.

Another set of parameters, in addition to structural niche, must be considered in describing the ecological distribution of lizards. These can be grouped as the lizard's "climatic niche." There are a variety of environmental factors that show parallel gradients here, among them insolation, light, temperature, and humidity. In general, one set of extremes for all these factors in the area is reached on or near the floor of the mature forest, and the other set is reached on the ground in clearings devoid of vegetation. Edges, second growth, and the top of the canopy show intermediate conditions.

The various lizards arrange themselves differently with respect to these gradients. To understand better the relationships of the lizards to the microclimates, we took a number of cloacal temperatures of the former while they were active in periods when the sun was shining; behavioral thermoregulation was possible at this time. In West Indian anoles similar data showed that the lizards in shaded habitats had lower body temperatures than those in open habitats (Ruibal, 1961; Rand, 1964).

The Belém data are a bit more complicated. Figure 2 shows the body temperature plotted against air temperatures taken in the immediate vicinity at the same time. These plots suggest that there are two very different kinds of thermal relationships represented among the Belém lizards: those whose temperature approximates that of the surrounding air and those whose temperature is much above it. A review of observations made of the various species shows that those in the first class were not seen basking while those in the second class were observed with definite basking behavior. Regarding this behavior, it seems safe to conclude that the high temperatures of the second group are due to behavioral thermoregulation and that they are heliotherms while the other group is not—at least at the ambient temperatures observed. (Since their temperature approximates the air and there is no evidence that they use substrates for thermoregulation, we prefer not to use "thigmotherm" but rather the more neutral "nonheliotherm.")

There is a definite relationship, but not unvarying, between thermal relationship and habitat used. The nonheliotherms are all inside the forest, and this is thermally the most constant habitat. The heliotherms occur in the more extreme environments in clearing, second growth, and canopy. One species of heliotherm, however, is almost entirely restricted to the area within the forest (*Kentropyx*), where it basks in the numerous patches of sun that reach the forest floor.

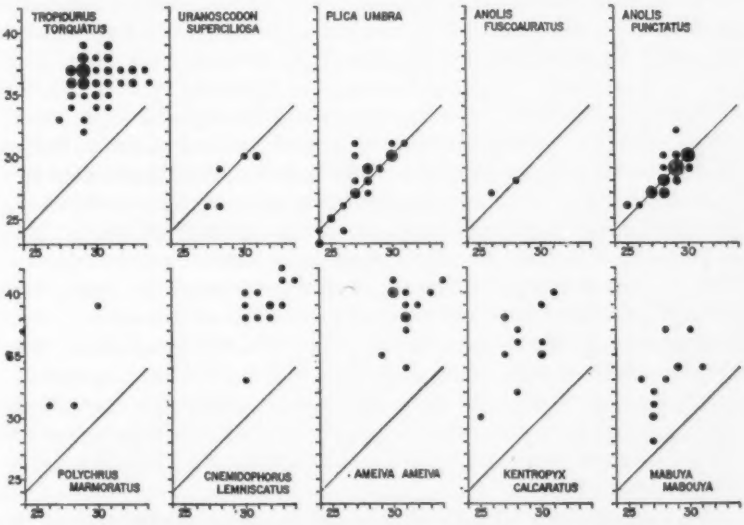

FIGURE 2.—Temperature relationships in Belém lizards: Cloacal temperature plotted against ambient air temperature at time of capture (temperatures in centigrade of just-captured lizards in natural habitat during day).

It should be noted from figure 2 that, under the conditions tested, the nonheliotherms in the forest are about as homeothermic as are the heliotherms that practice behavioral thermoregulation outside the forest (see Rand and Rand, 1966, for details of thermoregulatory behavior in *Tropidurus*). It certainly seems likely that the body temperatures of the open habitat animals would fluctuate much more than they are observed to do if the lizards did not practice some sort of thermoregulation. These data suggest that, if heliothermy has evolved to increase homeothermy rather than to produce high body temperature per se, then it has probably evolved in response to the fluctuating conditions in open environments. The data also suggest that the high body temperatures observed in heliotherms reflect the general principle

that, if an animal is to be diurnally active, heating is easier to accomplish than cooling in an area of high insulation.

The foregoing indicates that *Kentropyx* may be a recent invader of the forest from a macroteiid ancestor that was adapted basically to living in open habitats.

Though *Kentropyx* is the only primarily forest heliotherm, other heliotherms like *Tupinambis* and *Mabuya* also occur there. Low eccritic temperatures usually are associated with low temperature tolerances. Because of this and because the upper threshold of tolerance is usually sharper and more quickly lethal than the lower, it is probably easier and safer for open habitat animals to disperse through the forest than for forest animals to disperse through open habitats.

The role of interspecific competition is a basic problem in animal ecology. One of the reasons for our interest in the distribution of Belém lizards was that the evolution of differences in microdistribution has been suggested as an important strategy in reducing interspecific competition among sympatric lizard species (Rand, 1964; Milstead, 1957; and others). The basis for this suggestion in lizards has come usually from studies of sympatric congeners, but there seems no reason that it could not occur between sympatric relatives of different genera. Ecologists(e.g., MacArthur, Recher, and Cody, 1966) who attempt to discover environmental parameters that will predict bird species diversity seem to be assuming that a phylogenetic group as large as birds can be treated as an ecological unit for these purposes. We can make a similar assumption about the Belém lizards but, as we will show, it is probably wrong.

The clearest cases wherein differences in microdistribution can be associated with interspecific interactions are those wherein two or more species occur in the same area, utilize the same structural niche, and replace one another in different habitats or different climatic niches. The only case of such replacement suggested by the distributions plotted in figure 1 is the three smaller macroteiids. There is some overlap between these, but each species reaches its maximum abundance in a different environment: *Cnemidophorus* in the bare open patches, *Ameiva* in the edges and second growth, and *Kentropyx* in the forest. All three have similar foraging habits and could well compete if they occurred syntopically.

There are suggestions that size may be playing a role in reducing interaction between overlapping species. This is a strategy much seen in birds (Schoener, 1965, and others). In general, larger lizards take larger prey and this tends to reduce food competition among species of different sizes. In the Belém lizards, the very large macroteiid *Tupinambis nigropunctatus* widely overlaps *Ameiva ameiva* and *Ken-*

tropyx calcaratus. *Tupinambis* is several times the size of the others and as an adult takes much larger food. Another suggestive case is the two forest *Anolis* that occupy very similar structural and climatic niches but differ sharply in size. The third case is the difference between *Polychrus* and *Iguana*, the two lizards of the tree crowns. It seems unlikely that this size difference is related to food competition since *Iguana* is largely and *Polychrus* is partly herbivorous.

There is no evidence of the sort of temporal replacement during the day that Inger (1959) recorded in forest skinks in Borneo. Diurnal versus nocturnal replacement (perhaps involving the large nocturnal trunk gecko of the forest, *Thecadactylus rapicaudus*) is possible, but it is an unstudied problem.

The only major diet difference we now know (our examination of stomach contents has been limited and casual and there is much still to be learned) lies between the two species that regularly take a considerable amount of leaves and flowers, *Iguana iguana* and *Polychrus marmoratus*, and the remainder, which take largely or exclusively animal food. This diet difference plus the difference in structural niche separate the two herbivorous species very sharply from the rest.

To return to microdistribution as a mechanism for reducing species competition, there is considerable difference among species with respect to structural niches as there is with respect to climatic niches. Taken together, the microdistributions (fig. 1) do not show a regular pattern of replacement of one lizard by another because of the presence of overlaps between species (e.g., *Plica umbra* and *Anolis punctatus*) and of gaps between others (e.g., *Uranoscodon* and *Tropidurus torquatus*) in distribution. Since there is a lack of regular replacement, microdistribution does not suggest itself as an important factor in reducing interspecific competition among the lizards in general, though it may be so between certain species. As we have discussed, our observations on other strategies for reducing possible interspecific competition suggest that, even when all are considered together, no regular pattern of ecological separation among species appears. We are left with the impression, which we cannot prove rigorously, that the relationships of the lizard species to each other are not the over-riding factors in shaping their ecologies.

There are several possible explanations. It may be that our data are so incomplete that we have been given a completely erroneous impression. Further study may show that other species occur at Belém. This may fill the gaps in our picture and reveal differences among common species that would eliminate the apparent overlaps. Certainly, much more is to be learned and the latter possibility cannot be eliminated,

but, if for no other than heuristic reasons, it cannot be accepted as the only possibility.

There are two other possibilities not mutually exclusive that seem to us more likely. One is that lizards do not make an ecological unit. They, as a group, do not occupy a "lizard niche" that is subdivided among them; rather, the broad niche or niches that lizards occupy are occupied also by organisms of widely differing phylogenetic relationships with the result that several lizards in the same habitat may each have as its close competitors animals that are not lizards at all but other vertebrates or even invertebrates. It may not be coincidental that the most convincing studies of interspecific competition and mechanisms for reducing it in lizards come from the arid areas of North America and from those areas of the West Indies where lizards are very abundant both as individuals and species and play an important role in the trophic ecology. Certainly, one has the impression in the Belém area that inside the forest the disappearance of all lizards would not greatly upset the forest ecological economy if at all.

The relative rarity of lizards in the Belém forests suggests another possible explanation for the apparent lack of regularity in interspecific relationships. This is that populations of lizards are held at such low levels (perhaps by predation) that the populations never reach densities wherein interspecific competition for food or space occurs. It may be relevant that forest lizards are most common in the park areas, where many of the larger predatory birds, mammals, and perhaps snakes are rare or absent; these are also areas where the number of competitors may also be reduced.

Certainly, it is striking how little agonistic behavior one sees among iguanids in the Belém forests. This is in contrast to desert iguanids and those in the West Indies, where fighting or displaying between males is a common sight. One has the impression that the problem the forest lizards are usually faced with is not that of spacing out the population to avoid overcrowding but rather that of bringing together mates at the proper time. Among *Plica umbra*, *Anolis punctatus*, and *Gonatodes humilis*, we have the impression that we found individuals of the opposite sex near one another more often than we would have expected on chance alone. It may be that these lizards form pairs or at least that males and females permanently establish adjacent or overlapping home ranges in preference to living solitarily. The absence of territorial defense and the large amount of potential home range that seems unoccupied suggest that population densities are so low that direct intraspecific competition for exhaustible resources is nonexistent, and it also suggests that probably there is no inter-

specific competition between most lizard species and, consequently, no selection pressure for mechanisms that would reduce the competition.

If this is true, how can one account for the observed specialization in both climatic and structural niche? The answer is, of course, intraspecific competition in the Darwinian sense. When any species can exploit the available resources (in the broadest sense) more effectively by specializing in part of them, the specialization itself will be selected for unless this selection pressure is countered by selection in other directions. Specialization, by definition, involves loss of ecological amplitude, and selection against specialization is largely generated by temporal fluctuations in environmental conditions that generate a selection pressure for ecological amplitude (Pianka, 1967). In stable habitats—and the inside of the tropical rain forest is one of the most stable—the selection against specialization should be at its lowest.

It may be that low counterselection against specialization, rather than any unusually strong selection pressure for it, has produced some of the extreme specializations we see in tropical forest forms.

We have not the data to choose between these two hypotheses, which, in fact, are not mutually exclusive. It seems most likely that lizards as a block do not occupy a monolithic trophic niche but share a niche in a complex way with many other animals. It also seems likely that the low population levels in the forest lizards result in minimizing the importance of selective forces that arise from interspecific competition between many lizard species.

Conclusions

(1) The Belém area contains several different habitats and no species of lizard studied ranges uniformly through the area. (2) The forest is richest in number of species and the evidence suggests that this is at least in part because of its greater structural complexities. (3) Two types of thermal relationships with the environment are demonstrated by the lizard fauna: the heliothermic in both open and forest habitats and the nonheliothermic inside the forest. The latter show about as much homeothermism as the former because of the relatively low ambient temperature variation inside the forest. (4) The distribution of three species of macroteiid suggests that they replace one another ecologically. A fourth macroteiid that is syntopic with at least two of these is much larger. Two *Anolis* species that are syntopic and occupy very similar structural niches are different in size. (5) These replacements are probably important, but the impression of the distributions is one of irregular overlaps and gaps between niches of species. (6) The apparently unoccupied niches are

probably in part filled by animals that are phylogenetically distantly related to lizards, but ecologically the former should be considered with the latter. The lizards do not make an ecological unit. (7) The low population densities within the forest are such that interspecific competition may be relatively unimportant and ecological specialization may be the result of intraspecific competition for maximum efficiency of resource exploitation. Selection pressure for this must always exist, but the tropical rain forest, because of its great continuous extent and stability, probably generates unusually few counterselection pressures and, consequently, a high relative selection pressure toward specialization.

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Records and Descriptions of Additional Scoliidae from New Guinea, Bismarck Archipelago, and Solomon Islands (Hymenoptera: Aculeata)

By Karl V. Krombein

Chairman, Department of Entomology

Several hundred Scoliidae have been obtained in New Guinea, Bismarck Archipelago, and Solomon Islands by field parties of the Bernice P. Bishop Museum, Honolulu, since those reported upon in my revisionary study of these wasps (Krombein, 1963). I am grateful to J. L. Gressitt and C. M. Yoshimoto for supplying me the specimens for study. I have prepared the following brief paper inasmuch as included among the specimens are several distinctive new species and subspecies of *Campsomeris* subgenera *Laevicampsomeris* and *Phalerimeris*, and *Campsomeris*, sensu lato, the previously unrecognized males of two other species belonging to the subgenus *Laevicampsomeris*, and the previously unknown female of *Diliacos r. ribbei* (Betrem). Also, many specimens came from a number of new localities and provide additional data on seasonal occurrence of many species.

The species are arranged in systematic order as in my revisionary paper. The nomenclature employed is also the same except for the changes necessitated by two recent papers on classification of the Scoliidae (Betrem, 1962, 1967; Bradley and Betrem, 1967).

***Campsomeris (Laevicampsomeris) bonguensis* Betrem**

Northern District, Papua: 3 ♂, Popondetta, 60 meters, 2 and 26 September 1963, P. Shanahan and J. Sedlacek, in Malaise trap.

Central District, Papua: 3 ♂, Cape Rodney, 10 meters, 2–4 November 1960, J. L. Gressitt, 1 in Malaise trap. 2 ♂, Otomata Plantation, east of Port Moresby, 1 meter, 2 November 1960, J. L. Gressitt, in Malaise trap. 1 ♂, Brown River, 23 October 1960, J. L. Gressitt.

West New Guinea: 1 ♀, Dawai River, south-southeast of Sumberbaba, Japen Island, 3 November 1962, N. Wilson. 1 ♂, Nabire, 5–50 meters, 25 August–2 September 1962, J. Sedlacek, in Malaise trap. 1 ♂, Kebar valley, west of Manokwari, 550 meters, 4–31 January 1962, L. W. Quate.

***Campsomeris (Laevicampsomeris) nigerrima* (Smith)**

Northern District, Papua: 1 ♀, Popondetta, 60 meters, 26 September 1963, P. Shanahan, in Malaise trap.

West New Guinea: 1 ♀, Dawai River, south-southeast of Sumberbaba, Japen Island, 3 November 1962, N. Wilson.

Bismarck Archipelago: 2 ♀, 1 ♂, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 8–15 December 1962, J. Sedlacek. 1 ♂, Upper Warangoi, Gazelle Penin., 250–600 meters, 28–30 November 1962, J. Sedlacek. 2 ♂, Gaulim, Gazelle Penin., 130–140 meters, 23–28 October and 19–20 November 1962, J. Sedlacek. 1 ♀, Mt. Sinewit, Gazelle Penin., 900 meters, 7–16 November 1962, J. Sedlacek.

Males of *nigerrima* have not been recognized previously. These key to *laglaizei* Betrem, couplet 9 (Krombein, 1963, p. 553), and agree with that species in details of punctation and coloration. The genitalia of both *laglaizei* and *nigerrima* appear to be indistinguishable from those of *bonguensis* Betrem. The males of *nigerrima* recorded above are 18–23 mm long, and the forewing is 16–21 mm. It is presumed that the single *bonguensis* male recorded earlier from New Britain (Krombein, 1963, p. 568) is actually a specimen of *nigerrima*.

***Campsomeris (Laevicampsomeris) laglaizei* Betrem**

West New Guinea: 1 ♀, Dawai River, south-southeast of Sumberbaba, Japen Island, 3 November 1962, N. Wilson.

***Campsomeris (Laevicampsomeris) brandti* Krombein**

Bismarck Archipelago: 1 ♀, 1 ♂, Lelet Plateau, Schleinitz Mts., New Ireland, October 1959, W. W. Brandt.

This pair bears exactly the same label data as the female holotype (Krombein, 1963, p. 570), the only specimen known previously. The

male is 18 mm long with the forewing 16 mm. The genitalia are identical with those of *bonguensis* Betrem and other known Melanesian males of the subgenus *Laevicampsomeris*. The male keys to *solomonis* Krombein, couplet 10 (Krombein, 1963, p. 553), and cannot be separated from males of that species except by reference to label data.

***Campsomeris (Laevicampsomeris) solomonis solomonis*, new status**

I am reducing this taxon to subspecific rank because of the discovery of the distinctive new subspecies described below.

Solomon Islands: 1 ♂, Kukugai, Bougainville, 150 meters, November 1960, W. W. Brandt. 1 ♂, Ulo Crater, Vella Lavella Island, 10 meters, 16 December 1963, P. Shanahan. 1 ♂, Pepele, Kolombangara Island, 0–30 meters, 3 February 1964, P. Shanahan. 1 ♀, 1 ♂, Dala, Malaita Island, 50 meters, 9–14 and 21 June 1964, J. and M. Sedlacek. 2 ♂, Tambalia, 30 km west of Honiara, Guadalcanal, 22–25 May 1964, R. Straatman, J. and M. Sedlacek. 1 ♀, Betikama River, Guadalcanal, August 1960, W. W. Brandt. 1 ♀, Wugiroga, San Cristoval, 9 August 1960, C. W. O'Brien. 1 ♂, Kira Kira, San Cristoval, 0–50 meters, 10 November 1964, R. Straatman.

***Campsomeris (Laevicampsomeris) solomonis sedlaceki*, new subspecies**

At first glance, this anomalous member of the subgenus *Laevicampsomeris* reminds one of a female of *Campsomeris* (*Radumeris*) *extranea leveri* Krombein without the narrow yellow bands on the first three abdominal terga; however, it has such *Laevicampsomeris* characters as the lack of a carina between the dorsal and lateral propodeal surfaces, the very short, impunctate, nontuberculate median area of the dorsal propodeal surface, the pronounced oblique furrow on the scapula, large impunctate areas on the front, vertex, and thoracic dorsum, and the lack of a second recurrent vein in the forewing. What makes it so distinctive among the taxa of *Laevicampsomeris* is the bright fulvous vestiture on the entire body and the yellowish wings, whereas the vestiture and wings are black in the more typical members of the subgenus.

In my key the female runs to *solomonis*, couplet 8, if one disregards the character of wing color in couplet 4. It is separated at once from typical *solomonis* by the color of the vestiture and wings.

I assume that the male from Gizo Island, which I included in the type-series of typical *solomonis*, is actually the opposite sex of *solomonis sedlaceki*. It has the black integument, vestiture, and wings of *solomonis* males from other of the Solomon Islands. If this assumption is correct, we have in *solomonis sedlaceki* a taxon of *Laevicampsomeris* exhibiting a most unusual form of sexual dimorphism.

HOLOTYPE.—♀, Gizo Island, New Georgia Group, Solomon Islands, 100 meters, 16 July 1964, J. and M. Sedlacek, Bishop Museum.

Length 23 mm, forewing 18 mm. Exactly like typical *solomonis* in punctation and shape of longer hind tibial spur, but the vestiture fulvous, wings yellowish and lacking the green and blue reflections, and veins testaceous.

MALE.—Presumably identical to typical *solomonis* in color of vestiture and integument.

PARATYPE.—1 ♀, same data as holotype, but 19 July 1964, USNM. It is very similar to the holotype but is only 20 mm long.

Campsomeris (Laevicampsomeris) quatei, new species

This is known from a single female from West New Guinea. It is unique among females of this subgenus in having the entire posterior half of the vertex, scutellum, postscutellum, and median area of dorsal surface of propodeum with rather close punctures. It keys to couplet 8 and is distinguished from *nigerrima* (Smith) and *solomonis* Krombein as noted above.

HOLOTYPE.—♀, Bokondini, 40 km north of Baliem Valley, ca. 1300 meters, West New Guinea, 16–23 November 1961, L. W. Quate, Bishop Museum.

Length 25 mm, forewing 22 mm. Integument black; wings dark brown with purplish reflections, the margin of forewing darker. Vestiture black except that on clypeus and a few hairs on vertex light brown.

Clypeus with only a small median area and the apical rim impunctate; area frontalis and spatium frontale coarsely and closely punctate, upper part of front with scattered punctures; a narrow space anteriorly on vertex impunctate, elsewhere closely punctate.

Pronotum with moderately large, close punctures bearing stout erect setae, a narrow strip along posterior margin and anterior declivity impunctate; scutum with large contiguous punctures on anterior half and lateral third posteriorly, the median posterior space nearly smooth except for some punctures near midline; disks of scutum and scutellum with moderately sized, subcontiguous punctures except along midline; metapleuron and propodeum devoid of large punctures except median area of dorsal surface of propodeum with mostly subcontiguous, moderately large punctures.

Longer spur of hind tibia spatulate at tip, about two-thirds as long as hind basitarsus.

MALE.—Unknown.

Campsomeris (Laevicampsomeris) papuana, new species

The presence of abundant pale hair on the front, sides, and venter of head, the sides and venter of thorax (dorsum also in male), legs,

and on part (female) or all (male) of the abdomen distinguish this handsome species at a glance from other Melanesian members of the subgenus *Laevicampsomeris*.

The female runs to couplet 8 of my key (Krombein, 1963, p. 553). It has spatulate hind tibial spurs and moderately dense punctures on scutellum and postscutellum. This combination of characters coupled with the distinctive vestiture separate it from *nigerrima* (Smith) and *solomonis* Krombein, the two species keyed out in that couplet.

The male keys to couplet 9. It is separated from *laglaizei* Betrem and the species keying out in the subsequent couplet, *solomonis* and *bonguensis* Betrem, by a combination of characters such as the pale erect vestiture, lack of a propodeal tubercle, moderately dense punctation of the propodeal dorsum, and small yellow mark opposite the posteroventral margin of the eye. The genitalia, as is true in all Melanesian *Laevicampsomeris*, afford no differentiating characters.

HOLOTYPE.—♀, Karimui, south of Goroka, Eastern Highlands Dist., Terr. New Guinea, 1000 meters, 6 June 1961, J. L. and M. Gressitt, Bishop Museum.

Length 29 mm, forewing 24 mm. Integument black; wings fuscous, the forewing with purplish reflections. Erect vestiture brown to black on clypeus, vertex, dorsum of thorax including scapulae, terga three to six, and sterna five and six, whitish with an ocherous cast on front, sides, and venter of head, sides and venter of thorax, legs, and first and second abdominal segments; appressed preapical fringes of sterna two to four pale, apical fringes on sterna dark except for a few pale intermixed setae on second; sides and venter of thorax with abundant, silvery, sericeous pubescence.

Clypeus contiguously punctate except middle; area frontalis, spatium frontale, and a narrow strip on lower half of front between eyes densely and coarsely punctate; vertex and occiput densely and coarsely punctate except for a longitudinal median strip on vertex; setae arising from frontal, vertexal and occipital punctures coarse, erect and moderately long.

Scapulae, and anterior and lateral areas of scutum with dense, small punctures bearing conspicuous, erect setae, the impunctate median space on posterior half of scutum about a third as wide as scutal width and with a few scattered larger punctures; scutellum, postscutellum, and propodeal dorsum with subcontiguous punctures except for a narrow median strip; propodeum not tuberculate.

Posterior areas of terga and sterna shining; terga two to four mat on anterior two-thirds.

Legs with spurs of hind tibia spatulate at apex as in *bonguensis*, the longer one two-thirds as long as basitarsus.

ALLOTYPE.—♂, Karimui, 3 June 1961, J. L. and M. Gressitt, in Malaise trap, Bishop Museum.

Length 24 mm, forewing 20 mm. Integument mostly black, the dorsum of thorax and abdomen with weak blue reflections; the following creamy to yellowish: clypeus above and broadly on sides, narrow strip along inner eye margin to ocular sinus, short stripe adjacent to posteroventral eye margin, and apical half of foredistitarsus; wings fuscous, the forewing anteriorly with darker streak. Head, thorax, legs, and abdomen clothed with erect white setae except for a few intermixed dark setae on vertex and scutum, and the sixth and seventh terga with all dark setae; silvery sericeous pubescence on sides of thorax very conspicous, longer and denser than in female.

Propodeum with denser, larger punctures than in *bonguensis*, those on dorsal surface separated from each other by about the diameter of a puncture, tubercle absent; genitalia as in *bonguensis* (Krombein, 1963, p. 597, fig. 18).

PARATYPE.—1 ♂, same data as holotype, but 5 June 1961, J. L. and M. Gressitt, in light trap, USNM. The paratype is 25 mm long and agrees with the allotype in vestiture, punctation, and coloration.

Couplets 9 and 10 of my key may be expanded to include the males of these additional species of *Laevicampsomeris* as follows:

9. Median area of dorsal surface of propodeum with a distinct tubercle posteriorly, most of punctures on this area large and contiguous to subcontiguous 9a

Median area of dorsal surface of propodeum not tuberculate, most of punctures on this area finer and separated by more than the diameter of a puncture except in *papuana* and *solomonis* 10

9a. Side of clypeus with narrow yellow streak; propodeal punctation denser on dorsum in middle, many of punctures contiguous; New Guinea, Waigeu . . . . . **Campsomeris laglaizei** Betrem

Clypeus entirely black; propodeal punctation slightly sparser on dorsum in middle, many of punctures separated from each other by about half the diameter of a puncture; New Guinea, Misool, New Britain.

Campsomeris nigerrima (Smith)

10. Head, thorax, and most of abdomen with long, erect white hair; punctures on dorsum of median area of propodeum larger and denser, usually separated by no more than the diameter of a puncture; New Guinea.

Campsomeris papuana, new species

Erect hair almost entirely dark; propodeal punctures finer and more separated except in *solomonis* 10

10a. Clypeus with a narrow yellow stripe along lateral margin; propodeal punctation fine and well separated; New Guinea.

Campsomeris bonguensis Betrem

Clypeus entirely black 10b

10b. Foredistitarsus with a small yellowish spot; punctures on median area of propodeal dorsum finer and shallower, many of them separated by more than the diameter of a puncture; New Ireland.

Campsomeris brandti Krombein

Foredistitarsus black; punctures on median area of propodeal dorsum coarser, many of them separated by less than the diameter of a puncture; Solomon Islands . . . . . **Campsomeris solomonis** Krombein

***Campsomeris (Laevicampsomeris) formosa* (Guérin)**

Northern District, Papua: 3 ♀, Popondetta, 25 meters, June 1966, P. Shanahan and Lippert, in light trap.

Central District, Papua: 1 ♀, Bisianumu Station, 40 km north-northwest of Port Moresby, 29 April 1960, C. W. O'Brien. 1 ♂, Brown River, 23 October 1960, J. L. Gressitt.

Morobe District, Terr. New Guinea: 15 ♀, 6 ♂, Wau, 900–1300 meters, 25 February 1962, 23 March 1963 and 1964, 27–31 March 1964, 12 April 1963, 13 April 1964, 27 June 1961, 27 July 1964, 14, 15, 16, and 19 August 1964, 11 September 1964, 17 September 1961, 11 October 1962, 19 October 1965, 15 December 1961, J. and M. Sedlacek, C. Montieth, P. Shanahan, 3 ♂ in Malaise trap. 1 ♀, 1 ♂, Mt. Kaindi, Wau, 900–1800 meters, 12–14 June 1963, P. Shanahan. 3 ♀, 2 ♂, Mt. Misim, Wau, 900–1100 meters, 16 February 1963, 14 August and 25 September 1964, J. and M. Sedlacek. 1 ♂, Bulldog Road, ca. 14 km south of Edie Creek, 2405 meters, 4–10 July 1966, G. A. Samuelson, in Malaise trap. 1 ♀, Pindiu, Huon Peninsula, 860 meters, 22 April 1963, J. Sedlacek. 1 ♀, Singaua River, Lae, 30 meters, 8 April 1966, O. R. Wilkes.

Eastern Highlands District, Terr. New Guinea: 9 ♂, Kassam, 48 km east of Kainantu, 1350 meters, 30 October 1959, T. C. Maa.

West New Guinea: 1 ♀, 1 ♂, Ifar, Cyclops Mts., 300–900 meters, 23–25 June 1962, J. L. Gressitt and J. Sedlacek. 1 ♂, Kampong Landbouw, 30 km northeast of airstrip, Biak Island, 16 July 1957, J. L. and M. Gressitt, in light trap. 1 ♂, Sucumi Camp, near head of Ransiki River, Vogelkop, 300 meters, 6 August 1957, D. E. Hardy.

Bismarck Archipelago: 1 ♀, Riat, Upper Warangoi, Gazelle Peninsula, New Britain, 250 meters, 1 November 1962, J. Sedlacek. 1 ♀, Illugi, Upper Warangoi, Gazelle Penin., 15 December 1962, J. Sedlacek. 1 ♂, Gaulim, Gazelle Penin., 130 meters, 23–28 October 1962, J. Sedlacek.

Solomon Islands: 1 ♂, Kokugai, Bougainville, 150 meters, October 1960, W. W. Brandt. 2 ♂, Gollifer's Camp, Kolombangara Island, 100–700 meters, 22–23 January 1964, P. Shanahan, one in Malaise trap. 1 ♀, Kolosulu, Guadalcanal, 20 May 1960, C. W. O'Brien. 1 ♂, Betikama River, Guadalcanal, August 1960, W. W. Brandt.

The male from Gaulim, New Britain, has more reduced yellow markings than in any specimens noted in my revision. The scutellar spots are reduced in size, the band on postscutellum is lacking, reduced posterolateral spots are present on the first two terga only, and the sternal spots are smaller on two and three. The Vogelkop male lacks yellow maculations on both the scutellum and postscutellum, but abdominal bands are present on the first three terga, only

those on the third being narrowly separated. The vestiture in the latter specimen is normal for *formosa*.

***Campsomeris* (*Radumeris*) *tasmaniensis* (Saussure)**

Northern District, Papua: 1 ♀, 1 ♂, Popondetta, 20–60 meters, May 1966 and 2 September 1963, P. Shanahan and J. Sedlacek, ♂ in Malaise trap.

Central District, Papua: 1 ♂, Boroko, Port Moresby, 6–7 November 1960, J. L. Gressitt, in Malaise trap. 1 ♂, Otomata Plantation, east of Port Moresby, 1 meter, 2 November 1960, J. L. Gressitt, in Malaise trap. 1 ♂, Bisianumu Station, 40 km north-northwest of Port Moresby, 29 April 1960, C. W. O'Brien.

Western District, Papua: 1 ♀, 1 ♂, Daru Island, 2–3 meters, 19 July 1964 and 24–25 October 1960, J. L. Gressitt and H. Clissold, ♂ in Malaise trap. 1 ♀, Oriomo River, 6 meters, 14 February 1964, H. Clissold, in light trap.

Morobe District, Terr. New Guinea: 1 ♀, 1 ♂, Wau, 1200 meters, 12 April 1963 and 19 August 1964, J. Sedlacek.

West New Guinea: 7 ♂, Nabire, south of Geelvink Bay, 0–50 meters, 2–9 July and 25 August–20 September 1962, J. L. Gressitt, J. Sedlacek, H. Holtman, 1 in light trap and 6 in Malaise trap. 2 ♂, Enarotadi, Wisselmeeren, 1800–1900 meters, 27 July 1962, J. Sedlacek.

***Campsomeris* (*Radumeris*) *extranea moluccensis* Betrem**

Bismarck Archipelago: 2 ♂, Kandan, New Britain, 24 December 1959, W. W. Brandt. 1 ♂, Talliligap, Gazelle Peninsula, New Britain, 300 meters, 17–18 December 1962, J. Sedlacek.

Solomon Islands: 1 ♀, Fauro, northeast Solomon Islands, 12 April 1964, P. Shanahan.

One of the males from New Britain has the yellow band on the fourth tergum narrowly interrupted in the middle; the other male bearing identical label data has the normal coloration for this subspecies.

In my revision (Krombein, 1963, p. 585) I recorded *extranea moluccensis* from localities in New Guinea, Bismarck Archipelago, and Solomon Islands. In the latter group it was present only on the northernmost island, Bougainville, and was replaced by *extranea leveri* Krombein on the more southern islands, Santa Ysabel, Russell, Ulawa, and Guadalcanal. The present shipment from the Bishop Museum includes a female and two males of *extranea moluccensis* labeled as having been taken at Kira Kira, San Cristoval, 27–28 July 1960, by C. W. O'Brien. I am of the opinion that these specimens are mislabeled because San Cristoval lies to the southeast of Guadalcanal,

and we would expect to find it occupied by *extranea leveri*. This record becomes even more suspect when we note that in this material there is a specimen of the eastern New Guinea race, *Campsomeriella manokwariensis lanhami* (Krombein), bearing a "Kira Kira, San Cristoval" label as well as several specimens of *Austroscolia nitida nitida* (Smith), another taxon occurring in New Guinea and the Bismarcks. Both *Campsomeriella manokwariensis* and *Austroscolia nitida* are represented by other races in the Solomons. It appears probable that some of these presumably mislabeled specimens may have been collected in eastern New Guinea because of the specimen of *manokwariensis lanhami*, a race that occurs on the Huon Peninsula, Markham River Valley, and at Port Moresby.

***Campsomeris (Radumeris) extranea leveri* Krombein**

Solomon Islands: 1 ♂, Tambalia, 35 km west of Honiara, Guadalcanal, 30 meters, 22–25 May 1964, J. and M. Sedlacek.

***Campsomeris (Radumeris) extranea shanahani*, new subspecies**

The single female of this previously unrecognized taxon from Gizo Island in the New Georgia group differs from females of the other races of *extranea* in lacking yellow integumental markings on the abdomen and in the very reduced yellow spot adjacent to the upper inner eye margin. Disregarding the lack of yellow abdominal markings it keys without difficulty to *extranea* (couplet 23).

The putative male, represented by a short series from Vella Lavella Island in the New Georgia group, runs to *extranea* (couplet 34) if one disregards the lack of a yellow band on the postscutellum. It differs from males of the other races of *extranea* in having a very tiny yellow spot adjacent to the upper inner eye margin and in lacking yellow markings on the pronotum and postscutellum.

HOLOTYPE.—♀, Gizo Island, New Georgia group, Solomon Islands, 100 meters, 20 July 1964, J. and M. Sedlacek, in Malaise trap, Bishop Museum.

Length 18 mm, forewing 14 mm. Black, yellow markings lacking except for a tiny spot adjacent to upper inner eye margin. Vestiture dark fulvous on head and thoracic dorsum, whitish on sides of thorax and first abdominal segment; apical fringes of all terga and of fourth and fifth sterna dark brown, of second and third sterna light brown; decumbent setae on pygidium dark brown. Wings and punctation as in *extranea leveri*.

ALLOTYPE.—♂, Pusisama, Vella Lavella Island, Solomons; November 1963, P. Shanahan, in Malaise trap, Bishop Museum.

Length 19.5 mm, forewing 14.5 mm. Black, abdomen with weaker blue reflections than in *extranea leveri*, pale yellow maculations as

follows: mandible at base, sides and apex of clypeus more narrowly than in *extranea leveri*, line along inner eye margin to top of antennal insertions, very tiny spot in ocellocular area, narrow streak along posterior eye margin on lower two-thirds, a pair of small transverse spots on scutellum, tiny posterolateral spot on first tergum, a somewhat larger, transverse posterolateral streak on outer fourth of second tergum, a similar but shorter posterolateral streak on second sternum, small spot at apex of anterior surface of mid and hind femora, exterior surface of foretibia, and outer surface of forebasitarsus and distitarsus. Erect vestiture dark brown, appressed pubescence on side of thorax silvery. Wings slightly more infumated than in *extranea leveri*.

PARATYPES.—2 ♂, same data as allotype. 1♂, same data as allotype but 25 November 1963, USNM and Bishop Museum. Paratypes are 17–19 mm long. The color pattern is the same as described for the allotype except that one specimen has larger spots on the scutellum that are separated only narrowly on the midline, and the third tergum has a short posterolateral streak on the outer fourth. The genitalia are identical with those of the other subspecies of *extranea*.

***Campsomeris* (subgenus?) *oresbios oresbios* Tuijn**

Morobe District, Terr. New Guinea: 1 ♀, 2 ♂, Wau, 1200 meters, 10 November 1965, 9 December 1961, and 17 December 1965, J. and M. Sedlacek and P. Shanahan, in Malaise trap.

Bismarck Archipelago: 1 ♂, Gaulim, Gazelle Peninsula, New Britain, 130 meters, 23–28 October 1962, J. Sedlacek.

This race has not been recorded previously from New Britain, although it has a wide distribution in New Guinea. This specimen agrees well with darker maculated and haired specimens from New Guinea except that there is slightly less yellow on the clypeus and the wings are darker. Additional material, especially of females, may demonstrate that the population occurring in the Bismarck Archipelago should be recognized as a race discrete from the New Guinea taxon.

***Campsomeris* (subgenus?) *microspatulata* Tuijn**

Morobe District, Terr. New Guinea: 1 ♀, Wau, 1200 meters, 3 March 1963, J. Sedlacek. 1 ♂, Finschhafen, 14 April, J. and M. Sedlacek. 1 ♀, ca. 8 km west-northwest of Lab Lab, Umboi Island, 300 meters, 8–19 February 1967, G. A. Samuelson, in Malaise trap.

West New Guinea: 1 ♂, Nabire, south of Geelvink Bay, 10–40 meters, 7 October 1962, N. Holtmann, in Malaise trap in jungle.

***Campsomeris* (*Phalerimeris*) *loriae loriae* (Mantero)**

Central District, Papua: 1 ♂, Laloki, 10 February, F. Muir.

Eastern Highlands District, Terr. New Guinea: 1 ♂, Kassam, 48 km east of Kainantu, 1350 meters, 30 October 1959, T. C. Maa.

West New Guinea: 3 ♀, 3 ♂, Sibil Valley, Star Mts., 1250 meters, 18 October-8 November 1961, S. and L. Quate. 1 ♂, Ifar, Cyclops Mts., 300–500 meters, 28–30 June 1962, J. L. Gressitt and J. Sedlacek, in light trap. 5 ♀, 4 ♂, Bokondini, 40 km north of Baliem Valley, about 1300 meters, 16–23 November 1961, L. W. Quate. 1 ♀, 2 ♂, Moanemani, Kamo Valley, Wisselmeeren, 1500 meters, 15 August 1962, J. Sedlacek. 1 ♀, Itouda, Kamo Valley, Wisselmeeren, 1500–1700 meters, 18 August 1962, J. Sedlacek. 1 ♀, Dawai River, south-southeast of Sumberbaba, Japen Island, October 1962, N. Wilson.

***Campsomeris (Phalerimeris) loriae millironi* Krombein**

Solomon Islands: 1 ♀, Buin, Bougainville, 2 June 1956, J. L. Gressitt. 1 ♀, Pusisama, Vella Lavella, 17–18 November 1963, L. and M. Gressitt. 3 ♀, 1 ♂, Betikama River, Guadalcanal, August 1960, W. W. Brandt. 1 ♂, Tambalia, 35 km west of Honiara, Guadalcanal, 30 meters, 20 May 1964, J. and M. Sedlacek.

***Campsomeris (Phalerimeris) loriae kolombangarensis*, new subspecies**

This distinctive melanic race of *loriae*, known only from males, is separated from the other races of *loriae* by the reduced yellow markings. Although it is now known to occur only on Kolombangara in the New Georgia group, it is quite likely that it will be found on the other islands in that group when more extensive collecting has been accomplished. The closest congener, *loriae millironi* Krombein, is known from Guadalcanal, Florida, Rendova, Vella Lavella, and Bougainville Islands in the Solomons, and from New Britain in the Bismarck Archipelago. It differs from *loriae millironi* in having the clypeus black except sides, yellow markings very reduced or lacking on the pronotum, and the postscutellum, abdomen (almost entirely), and legs black. The genitalia are identical with those of the other subspecies.

HOLOTYPE.—♂, Iriri, Kolombangara, New Georgia group, Solomon Islands, 2 meters, 3 July 1964, J. and M. Sedlacek, Bishop Museum.

Length 14 mm, forewing 12 mm. Black, abdomen with faint blue reflections, yellow as follows: mandible on basal two-thirds, spot at lower corner of clypeus, short stripe along inner eye margin to antennal insertion, a pair of tiny spots anteriorly on pronotal disk, and short posterolateral streak on second tergum; tip of mandible and lower edge of clypeus reddish.

PARATYPES.—3 ♂, same data as holotype, USNM and Bishop Museum. These are uniform in size. Two of them lack yellow spots on the pronotum.

***Campsomeris (Phalerimeris) ferrugineipes ferrugineipes* (Mantero)**

West New Guinea: 3 ♀, Moanemani, Kamo Valley, Wisselmeeren, 1500 meters, 15 August 1962, J. Sedlacek.

***Campsomeris (Phalerimeris) ferrugineipes pembertoni* Krombein**

Bismarck Archipelago: 7 ♂, Talliligap, Gazelle Peninsula, New Britain, 300 meters, 17–18 December 1962, J. Sedlacek.

***Campsomeriella (Campsomeriella) manokwariensis manokwariensis* (Cameron)**

West New Guinea: 6 ♂, Hollandia [Kota Baru], 25–28 June 1962, N. Wilson. 1 ♀, Bokondini, 40 km north of Baliem Valley, about 1300 meters, 16–23 November 1961, S. and L. Quate. 1 ♂, Itouda, Kamo Valley, Wisselmeeren, 1500–1700 meters, 18 August 1962, J. Sedlacek. 3 ♂, Enarotadi, Wissel Lakes, 1800–2000 meters, 2–11 and 27 July 1962, N. Wilson and J. Sedlacek, 2 by sweeping. 1 ♀, Dawai River, south-southeast of Sumberbaba, Japen Island, 3 November 1962, N. Wilson. 2 ♀, Biak Island, 22–30 June 1962, J. L. Gressitt and J. Sedlacek, in light trap. 1 ♂, southeast Biak Island, 1 July 1962, J. L. Gressitt. 9 ♀, 16 ♂, Nabire, south of Geelvink Bay, 0–50 meters, 2–9 July, 25 August–2 September, 1–4, 7, and 17 September, 4, 7, 10, and 13 October 1962, J. Sedlacek, J. L. Gressitt, H. Holtmann, N. Wilson, 1 each in Malaise and light traps.

Bismarck Archipelago: 1 ♀, Kerawat, New Britain, 6 May 1956, G. Dun.

***Campsomeriella (Campsomeriella) manokwariensis lanhami* (Krombein)**

The Bishop Museum material included one female of this eastern New Guinea race undoubtedly mislabeled as being from Kira Kira, San Cristoval, Solomon Islands, 27 July 1960, C. W. O'Brien (see my earlier remarks on these presumably mislabeled specimens under *Campsomeris extranea moluccensis*). This particular female agrees with the eastern New Guinea race in having the more lightly infuscated basal two-thirds of the forewing and white tergal fringes on the first four terga in contrast to the Solomon Islands race *manokwariensis manni* (Krombein), which has similarly colored wings but only the first three tergal fringes white, that on the fourth being brown.

***Campsomeriella (Campsomeriella) manokwariensis manni* (Krombein)**

Solomon Islands: 1 ♀, Pusisama, Vella Lavella Island, 29 November 1963, P. J. Shanahan.

***Trisciloa saussurei* Gribodo**

Morobe District, Terr. New Guinea: 1 ♂, Wau, 1250 meters, 3 January 1963, J. Sedlacek. 1 ♂, Lae, 26 November 1961, J. Sedlacek. 1 ♂, Zenag-Lae, 200 meters, 15 January 1965, J. Sedlacek.

West New Guinea: 1 ♂, Ifar, Cyclops Mts., 300–500 meters, 28–30 June 1962, J. L. Gressitt and J. Sedlacek, in light trap. 1 ♀,

5♂, Kebar Valley, west of Manokwari, 550 meters, 4–31 January 1962, L. W. Quate. 1 ♂, Oransbani, south of Manokwari, February 1962, L. Richards.

***Liacos fulgidipennis* (Smith)**

Northern District, Papua: 1 ♀, Popondetta Mission, 60 meters, 18 October 1963, P. Shanahan.

Morobe District, Terr. New Guinea: 1 ♀, 2 ♂, Wau, 1050–1400 meters, 26 May 1965, 9 July 1963, and 11 September 1961, P. Shanahan, J. and M. Sedlacek, 1 ♂ in Malaise trap. 1 ♀, Finschhafen, Huon Peninsula, 20–150 meters, 15 April 1963, J. Sedlacek.

West New Guinea: 1 ♀, Kebar Valley, west of Manokwari, 550 meters, 4–31 January 1962, S. Quate.

***Diliacos quadriceps* (Smith)**

In my revision (1963, pp. 613–616) I used the name *Scolia* (*Diliacos*) *larradiformis* Smith, 1863, for a polytypic species occurring in New Guinea and the Admiralty Islands, and I suggested the possibility that the taxon I regarded as typical *larradiformis* might be identical with *quadriceps* Smith, 1859, from Aru. Betrem has restudied these types subsequently and has found that they are indeed identical (Bradley and Betrem, 1967, p. 311). The correct names for the taxa, therefore, that I placed under *larradiformis* are as follows:

Diliacos quadriceps grandiceps (Micha), p. 613
Diliacos quadriceps quadriceps (Smith), p. 615
Diliacos quadriceps manus (Krombein), p. 615

***Diliacos quadriceps grandiceps* (Micha)**

Morobe District, Terr. New Guinea: 4 ♀, 2 ♂, Wau, 1050–1200 meters, 27 January 1966, 24 May 1965, and 16 September, 22 October, 9 November 1965, and 19 November 1961, J. and M. Sedlacek, 1 ♀, 3 ♂ in Malaise trap. 3 ♂, Kunai Creek, Wau, 1250–1500 meters, 28–30 May and 26 August 1963, P. Shanahan and J. Sedlacek, 1 in Malaise trap.

***Diliacos ribbei stueberi* (Krombein)**

Eastern Highlands District, Terr. New Guinea: 3 ♀, 13–20 km southeast of Okapa, 1650–2250 meters, 24 and 26 August 1964, J. and M. Sedlacek.

West New Guinea: 3 ♀, Hollandia, 0–300 meters, 22 December 1961–21 January 1962, S. and L. Quate. 1 ♂, Bokondini, 40 km north of Baliem Valley, ca. 1300 meters, 16–23 November 1961, L. W. Quate. 1 ♂, Oransbari, northwest of Geelvink Bay, 16 February 1963, R. Straatman.

***Diliacos ribbei ribbei* (Betrem)**

Bismarck Archipelago: 2 ♀, 1 ♂, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 8–11 and 12–15 December 1962, J. Sedlacek. 1 ♀, Gaulim, Gazelle Penin., 140 meters, 21–26 October 1962, J. Sedlacek.

Females of the typical subspecies of *ribbei* were unknown previously. These specimens from New Britain key to couplet 62 (Krombein, 1963, p. 563). Females of typical *ribbei* are intermediate in density of punctation between *ribbei stueberi* (Krombein) from northern New Guinea and *ribbei hurdi* (Krombein) from the Solomon Islands. As in *ribbei stueberi* the front between the spatium frontale and the anterior ocellus is impunctate except for a few scattered punctures in the ocular sinus and along the inner eye margin, but the ocellar triangle has one or two punctures instead of being impunctate and the posterior half of the scutum has 15–20 scattered punctures between the parapsidal furrows instead of being impunctate. In contrast, the more densely punctate *ribbei hurdi* has about 30 punctures on the front between the spatium frontale and anterior ocellus, the ocellar triangle has half a dozen punctures, and the posterior half of the scutum has 44–50 punctures between the parapsidal furrows. Each female of *ribbei ribbei* has only two discoidal cells in the forewing. They are 13–15 mm long, and the forewing is 10–12 mm long.

***Diliacos ribbei hurdi* (Krombein)**

Solomon Islands: 1 ♀, Pepele, Kolombangara Island, 0–30 meters, 3 February 1964, P. Shanahan. 1 ♂, Iriri, Kolombangara, New Georgia Group, 2 meters, 3 July 1964, J. and M. Sedlacek. 1 ♂, Nalimbu River, 29 km southeast of Honiara, Guadalcanal, 5 June 1960, C. W. O'Brien.

***Diliacos glabrata glabrata* (Micha)**

Northern District, Papua: 1 ♀, Popondetta Mission, 60 meters, 18 October 1963, P. Shanahan. 1 ♀, Gona Road, Popondetta District, 60 meters, 30 October 1963, H. W. Clissold.

Morobe District, Terr. New Guinea: 3 ♀, 1 ♂, Wau, 1200–1300 meters, 1 and 14–17 January 1963, 17 May 1965, and 14 November 1965, J. and M. Sedlacek and P. Shanahan, 2 ♀ in Malaise trap. 1 ♀, 24 km west of Bulolo, Upper Watut River, 760 meters, 5–6 March 1963, J. Sedlacek. 1 ♀, ca. 8 km west-northwest of Lab Lab, Umboi Island, 300 meters, 8–19 February 1967, G. A. and S. L. Samuelson, and P. H. Colman.

West New Guinea: 1 ♀, Genjam, 40 km west of Hollandia, 100–200 meters, 1–10 March 1960, T. C. Maa.

***Diliacos glabrata praslini* (Bradley)**

Bismarck Archipelago: 1 ♀, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 12–15 December 1962, J. Sedlacek.

Solomon Islands: 1 ♂, Kukugai, Bougainville, 150 meters, October 1960, W. W. Brandt. 1 ♀, 1 ♂, Gizo Island, New Georgia Group, 50–120 meters, 16–26 April 1964, J. Sedlacek, in Malaise trap. 6 ♂, Pepele, Kolombangara Island, New Georgia Group, 30 meters, 7–9 February 1964, P. Shanahan, in Malaise trap. 2 ♂, Kow, Vella Lavella, 30 meters 28 November 1963, P. Shanahan, in Malaise trap. 7 ♂, Ulo Crater, Vella Lavella, 10 meters, 16–21 December 1963, P. Shanahan, 4 in Malaise trap. 1 ♂, Kolotuve, Santa Ysabel, 21 June 1960, C. W. O'Brien. 1 ♂, Kolotuve-Sukapisu, Santa Ysabel, 20 June 1960, C. W. O'Brien. 1 ♀, Takopekope, Florida Group, 12 November 1960, C. W. O'Brien, in light trap. 1 ♀, Guadalcanal, 12–20, J. A. Kusche. 3 ♀, 4 ♂, Betikama River, Guadalcanal, August and September 1960, W. W. Brandt. 1 ♀, Kiwi Creek, Guadalcanal, 18 September 1944, H. E. Milliron. 2 ♂, Napagiwae, San Cristoval, 19 August 1960, C. W. O'Brien.

***Microscolia maindroni* (Betrem)**

West New Guinea: 1 ♂, Oransbari, northwest of Geelvink Bay, 16 February 1963, R. Straatman.

***Carinoscolia lorentzi* (Cameron)**

Morobe District, Terr. New Guinea: 1 ♂, Wau, 1050 meters, 18 December 1961, J. and J. H. Sedlacek. 1 ♂, Lae, 26 November 1961, J. Sedlacek. 1 ♂, Finschhafen, Huon Peninsula, 150 meters, 15 April 1963, J. Sedlacek.

***Carinoscolia foveifrons* (Cameron)**

Bismarck Archipelago: 1 ♀, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 8–11 December 1962, J. Sedlacek. 1 ♀, Lelet Plateau, Schleinitz Mts., New Ireland, October 1959, W. W. Brandt.

Solomon Islands: 1 ♂, Ulo Crater, Vella Lavella Island, 10 meters, December 1963, P. Shanahan. 1 ♂, Dala, Malaita Island, 50 meters, 22 June 1964, J. and M. Sedlacek, in Malaise trap. 1 ♂, Betikama River, Guadalcanal, August 1960, W. W. Brandt.

The present records extend the range of this species considerably to the south in the Solomons, the only previous record from that group being from Bougainville.

Austroscolia pulchripennis pulchripennis (Cameron)

Western Highlands District, Terr. New Guinea: 2 ♂, Tomba, 2450 meters, 24 May 1963, J. Sedlacek.

Bismarck Archipelago: 1 ♀, 5 ♂, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 8–15 December 1962, J. Sedlacek. 2 ♂, Gaulim, Gazelle Penin., 140 meters, 21–27 October 1962, J. Sedlacek. 1 ♂, Talliligap, New Britain, 300 meters, 17–18 December 1962, J. Sedlacek. 1 ♂, Lelet Plateau, Schleinitz Mts., New Ireland, October 1959, W. W. Brandt.

Solomon Islands: 21 ♂, Dala, northwest Malaita, 6–22 June 1964, R. Straatman, J. and M. Sedlacek, 1 in MV light trap.

In my revision (Krombein, 1963, p. 638) I questioned the occurrence of this taxon in New Guinea on the basis of an old, possibly mislabeled specimen from West New Guinea. The two males recorded above from Tomba in the western part of the Territory of New Guinea definitely establish the presence of this subspecies in New Guinea as well as in the Bismarcks and on Malaita Island alone of the Solomons.

Austroscolia pulchripennis franclemonti (Krombein)

Morobe District, Terr. New Guinea: 1 ♀, 1 km north of Awelkom, Umboi Island, 600 meters, 21–28 February 1967, S. L. and G. A. Samuelson.

Solomon Islands: 2 ♂, Kukugai, Bougainville, 150 meters, October and December 1960, W. W. Brandt. 1 ♀, 4 ♂, Gizo Island, New Georgia Group, 30–120 meters, 16–26 April and 19 July 1964, J. and M. Sedlacek, ♀ in Malaise trap. 1 ♂, Iriri, Kolombangara Island, 2 meters, 29 June 1964, J. and M. Sedlacek. 2 ♂, Kolotuve, Santa Ysabel, 21 June 1960, C. W. O'Brien. 1 ♂, Betikama River, Guadalcanal, August 1960, W. W. Brandt.

The female from Umboi Island is only 24 mm long. The smaller male is only 17 mm long. Both of these are smaller by a millimeter or two than the previously recorded minimal length.

Austroscolia betremianus (Krombein)

Bismarck Archipelago: 1 ♀, 3 ♂, Mt. Sinewit, Gazelle Peninsula, New Britain, 900–1200 meters, 5–16 November 1962, J. Sedlacek. 1 ♂, Upper Warangoi, Gazelle Penin., 250–600 meters, 28–30 November 1962, J. Sedlacek. 1 ♂, Illugi, Upper Warangoi, 230 meters, 12–15 December 1962, J. Sedlacek. 2 ♀, 2 ♂, Lelet Plateau, Schleinitz Mts., New Ireland, October 1959, W. W. Brandt.

The present series establishes the range of length in females as 20–25 mm.

Austroscolia nitida nitida (Smith)

Northern District, Papua: 1 ♀, 1 ♂, Popondetta, 5–60 meters, June 1966 and 26 September 1963, P. Shanahan, Gressitt and Tawi, ♂ in Malaise trap.

Central District, Papua: 1 ♂, Port Moresby, 6–7 November 1960, J. L. Gressitt, in Malaise trap.

Morobe District, Terr. New Guinea: 1 ♂, 35 km south of Lae, 120 meters, 6 August 1964, J. and M. Sedlacek. 1 ♂, Markham River, 60 meters, 8 August 1964, J. Sedlacek, in Malaise trap. 9 ♀, 36 ♂, Wau, 650–2400 meters, 9–12 January 1962, 15, 21–25, and 26 January 1963, 3 and 27–31 March 1964, 2 April 1966, 16–20 April 1962, 14 and 18 May 1965, 12–14 June 1963, 15 and 29 August 1961, 2, 10, 12, 17, 19, and 30 September 1961, 16–18 September 1964, 4 and 5 October 1962, 12 October 1965, 19 and 30 October 1961, 6–7 November 1961, 3 December 1962, and 18 December 1961, J., J. H., and M. Sedlacek, C. Monteith, P. Shanahan, and a native, several in Malaise trap, 3 on lucerne, 1 in light trap. 2 ♀, 10 ♂, Mt. Misim, Wau, 950–1600 meters, 13 and 16 February 1963, 14 August and 25 September 1964, J. and M. Sedlacek, 7 ♂ in Malaise trap. 1 ♀, Kunai Creek, Wau, 1500 meters, 28–30 May 1963, P. Shanahan. 1 ♀, 11.2 km north of Bulolo, 600 meters, 11 March 1962, J. H. Sedlacek. 1 ♂, Adelbert Mts., 800–1000 meters, 25 October 1958, J. L. Gressitt.

Eastern Highlands District, Terr. New Guinea: 1 ♂, Goroka, 1500 meters, 22 May 1961, J. L. Gressitt. 1 ♀, 1 ♂, Karimui, 1080 meters, 10 and 15 July 1963, J. and M. Sedlacek. 5 ♀, 12 ♂, Purosa, 20–26 km southeast of Okapa, 1700–2020 meters, 17–25 May 1966 and 28 August 1964, J. and M. Sedlacek, Gressitt and Tawi.

Western Highlands District, Terr. New Guinea: 9 ♀, 1 ♂, Tambul, 1200 and 2250 meters, 26 May and 2 June 1963, J. Sedlacek. 1 ♂, 6–12 km west of Wabag, 2020–2400 meters, 13 June 1963, J. Sedlacek.

West New Guinea: 3 ♀, Sibil Valley, Star Mts., 1245 meters, 18 October–8 November 1961, S. and L. W. Quate. 1 ♂, Hollandia, 13 March 1960, T. C. Maa. 7 ♂, Hollandia to Kotanica, 25–28 February 1960, T. C. Maa. 1 ♀, Ifar, Cyclops Mts., 300–500 meters, 26–28 June 1962, J. Sedlacek. 3 ♂, Bokondini, 40 km north of Baliem Valley, ca. 1300 meters, 16–23 November 1961, S. and L. Quate. 4 ♀, 20 ♂, Wamena, 1700 meters, 10–25 February 1960, T. C. Maa. 1 ♀, Moanemani, Kamo Valley, Wisselmeeren, 1500 meters, 15 August 1962, J. Sedlacek. 1 ♂, Nabire, south of Geelvink Bay, 10–40 meters, 12 October 1962, N. Wilson.

There is also before me a series of one female and six males of typical *nitida* labeled as having been taken at Kira Kira, San Cristoval, Solomon Islands, 27 and 28 July 1960, by C. W. O'Brien. The *nitida*

population occurring elsewhere in the Solomons is *nitida punctatissima* (Kirby). I regard these San Cristoval specimens as being mislabeled and suspect that they were actually collected in eastern New Guinea as discussed in my remarks earlier under *Campsomeris extranea moluccensis* Betrem.

***Austroscolia nitida varifrons* (Cameron)**

Morobe District, Terr. New Guinea: 8 km west-northwest of Lab Lab, Umboi Island, 300 meters, 8–9 February 1967, S. L. and G. A. Samuelson, P. H. Colman.

Eastern Highlands District, Terr. New Guinea: 1 ♂, Simbai, Bismarck Range, 1850 meters, 27 May 1966, J. L. Gressitt.

Western Highlands District, Terr. New Guinea: 1 ♂, Tomba, 2450 meters, 24 May 1963, J. Sedlacek.

Bismarck Archipelago: 1 ♂, Illugi, Upper Warangoi, Gazelle Peninsula, New Britain, 230 meters, 8–11 December 1962, J. Sedlacek. 2 ♂, Talliligap, Gazelle Penin., 300 meters, 17–18 December 1962, J. Sedlacek. 1 ♂, Mt. Sinewit, Gazelle Penin., 1100–1200 meters, 15–16 November 1962, J. Sedlacek. 1 ♀, Lelet Plateau, Schleinitz Mts., New Ireland, October 1959, W. W. Brandt.

***Austroscolia nitida punctatissima* (Kirby)**

Solomon Islands: 1 ♂, Kokugai, Bougainville, 150 meters, December 1960, W. W. Brandt. 1 ♀, 2 ♂, Pusisama, Vella Lavella Island, 17–29 November 1963, L. and M. Gressitt, P. Shanahan. 1 ♀, 3 ♂, Munda, New Georgia, 1–30 meters, 21 July 1959, J. L. Gressitt. 1 ♂, Iriri, Kolombangara, New Georgia Group, 2 meters, 3 July 1964, J. and M. Sedlacek. 3 ♂, Sandfly Harbor, Kolombangara, 5–200 meters, 6–8 July 1964, J. and M. Sedlacek, 1 in light trap. 1 ♂, Gollifer's Camp, Kolombangara, 700 meters, 24 January 1964, P. Shanahan. 1 ♂, Pepele, Kolombangara, 30 meters, 15 February 1964, P. Shanahan. 1 ♂, Buala, Santa Ysabel, 27 June 1960, C. W. O'Brien. 1 ♂, Molao, Santa Ysabel, 29 June 1960, C. W. O'Brien. 1 ♂, Kolotuve, Santa Ysabel, 21 June 1960, C. W. O'Brien. 1 ♂, Dala, northwest Malaita Island, 30 June 1964, R. Straatman, in Malaise trap. 1 ♂, Denda, Small Nggela, Florida Group, 17 September 1960, C. W. O'Brien. 1 ♀, 5 ♂, Guadalcanal, 13 June and 16 July 1944. 6 ♂, Betikama River, Guadalcanal, August 1960, W. W. Brandt. 1 ♂, Honiara, Guadalcanal, 22 April 1964, R. Straatman. 2 ♂, Kira Kira, San Cristoval, 0–50 meters, 29 July 1960, C. W. O'Brien, and 13 November 1964, R. Straatman, in Malaise trap. 3 ♂, Wugiroga, San Cristoval, 8–9 August 1960, C. W. O'Brien. 1 ♂, Napagiwae, San Cristoval, 19 August 1960, C. W. O'Brien.

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[1] In this publication, the following errata appeared:
Page 552—second alternative of couplet 2 should lead to 43.
Page 617—figure reference to female head of *ribbei stueberi* should be 15 not 5.
Page 638—line 14 from bottom should read "NEW BRITAIN, BISMARCKS. 1 ♀, 1 ♂; Kinigunang (C. Ribbe) [CU]. 3 ♂;".

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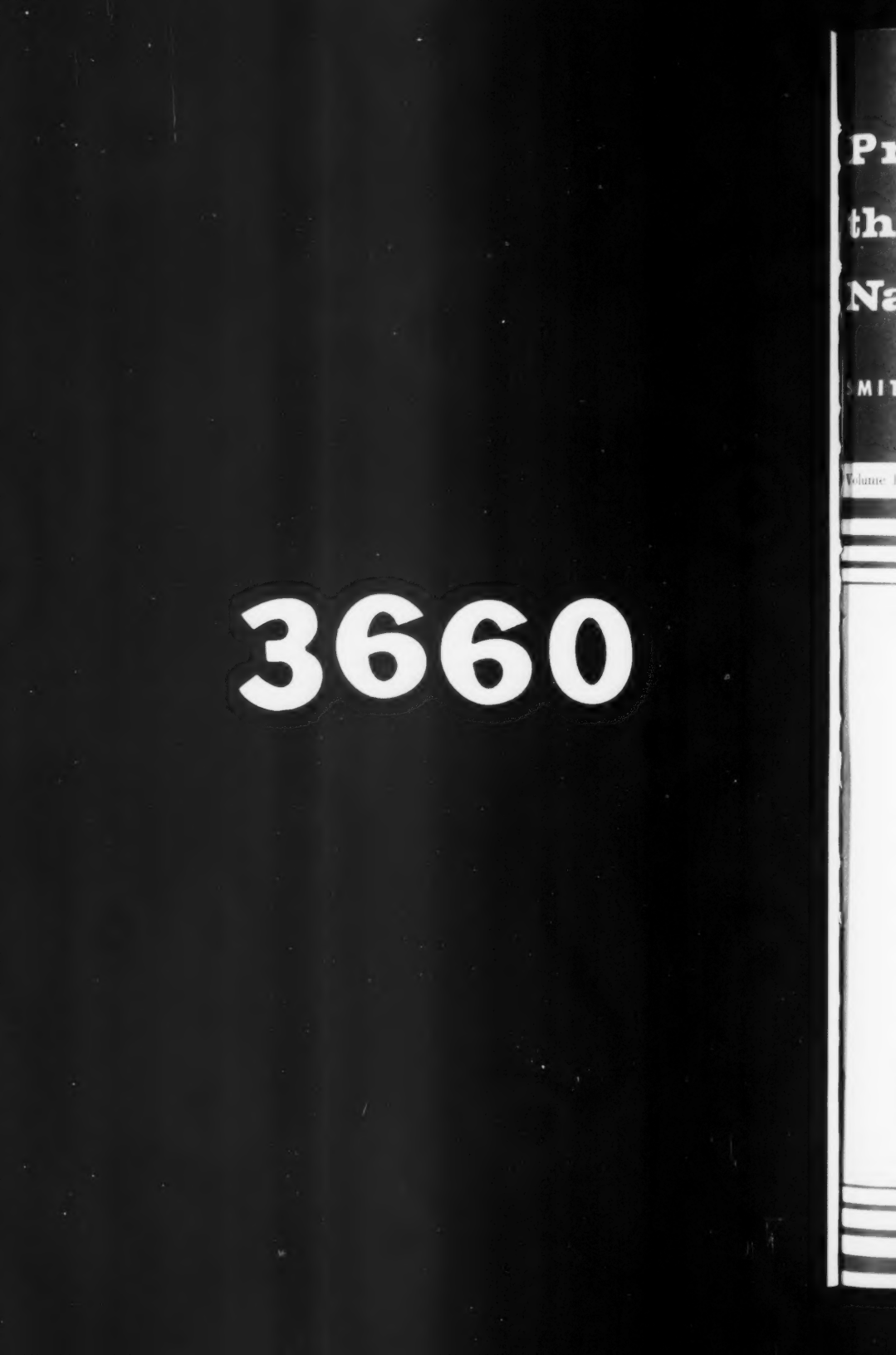
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Neotropical Microlepidoptera, XVII[1]

Notes and New Species of Phaloniidae

By J. F. Gates Clarke

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For several years I have been engaged, somewhat sporadically, on a revision of the American Phaloniidae. Because this revision will not be completed for several more years—indeed, there is yet much to be done—I wish to make known the new taxa described below and to clarify the status of several previously described forms.

None of the previously published species have been illustrated before (except *Phalonia embrithopa* Meyrick; Clarke, 1963, pl. 13: figs. 1–1a), but all the species included in this paper are being figured.

In recent years several investigators (Busck, 1939; Razowski, 1964) have attempted classifications of this family, but for the most part the treatments have been based on characters of the male genitalia. Not only have the females been neglected but also, when they have been used, the accessory bursa has generally been omitted from the figures and it has not been employed in classification. Actually, the value of this feature and its origin in relation to associated structures are not presently known. The reason for this state of affairs is that

[1] See list at end of paper.

apparently it is seldom seen by the investigators, is destroyed during the preparation of the genitalia mounts, and is now missing from most slides.

Busck (1939) illustrated the accessory bursa of several species but did not use it in his classification. His keys are based on male genitalia and wing venation. Razowski (1964) does not illustrate the accessory bursa at all, nor does he allude to it anywhere in his papers. At this time I am not using it in classification, although I am illustrating it wherever it could be found, but I believe that many more preparations of many species in numerous genera must be made before we can evaluate its true significance. In most species of most genera the accessory bursa has its inception posteriorly, either from the bursa copulatrix or the ductus bursae. In the species group consisting of *vesta*, *tornosema*, and *charma* this structure emerges anteriorly. Surely such differences are significant. The male *vesta*, the only male known for this group, suggests affinity with *Phalonidia* and *Amallectis*, but the females of these two genera do not exhibit the anterior origin of the accessory bursa. Since it is not clear at this time to what genus these three species are referable, I am placing them in the genus *Phalonia* until all the genera have been examined properly and revised.

Unfortunately, phaloniids seldom are collected in sufficient series to permit exhaustive study, and all too frequently one or the other sex is missing. The state of our knowledge, therefore, is imperfect but it is hoped that papers such as this will point out the need for more material so that more complete treatments can be presented. There is an appalling lack of biological information on the New World species, particularly the Neotropical representatives, but it will be a long time before microlepidopterists will be able to devote time to life history studies in the latter region. In the meantime we must content ourselves with making known the existing taxa.

The drawings of the genitalia were made by Mr. André del Campo Pizzini, staff artist. The photographs of the wings were made by Mr. Jack Scott and Mr. Victor Krantz.

Hysterosia Stephens

Hysterosia gigantica Busck

FIGURE 1; PLATE 1 (FIG. 5)

Hysterosia gigantica Busck, 1920, Ins. Insc. Mens., vol. 8, nos. 4–6, p. 87.

Female genitalia slide JFGC no. 11621. Ostium broad, slitlike, with posteroventral edge curved ventrally. Antrum membranous. Inception of ductus seminalis from deep concavity in side of bursa copulatrix. Ductus bursae very short; anterior portion ridged, the ridges continuing into bursa copulatrix. Bursa copulatrix studded with spicules

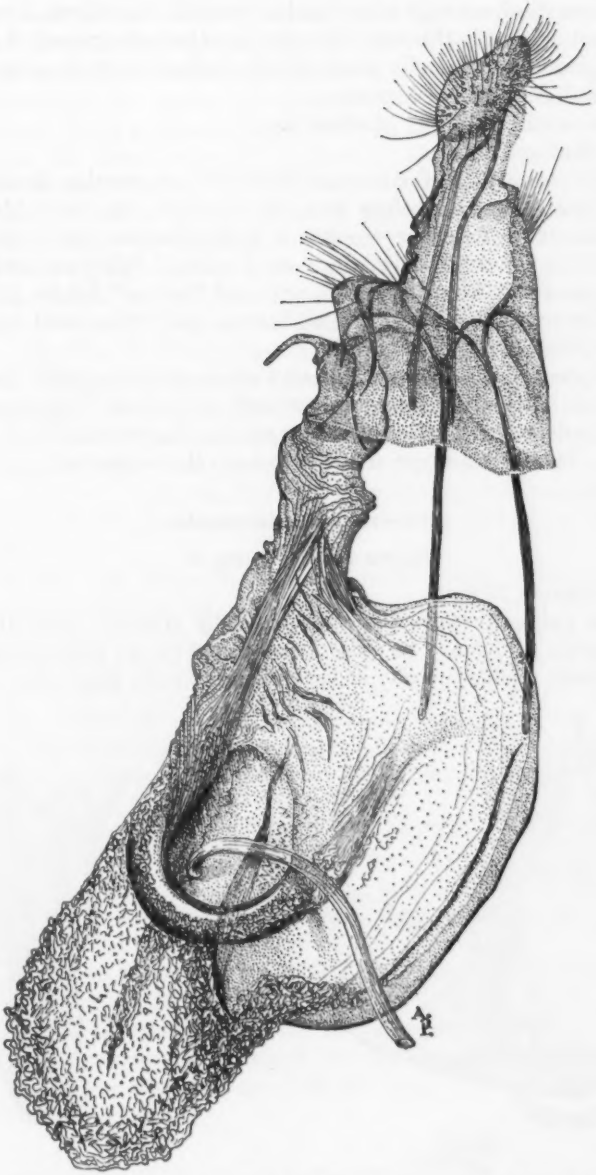


FIGURE 1.—*Hysterosia gigantica* Busck: lateral aspect of female genitalia.

in anterior third, strongly sclerotized in posterior two-thirds. Accessory bursa not evident in this example (may have been destroyed). Lamella antevaginalis and lamella postvaginalis rather strongly sclerotized.

Type: U.S. National Museum.

Type-locality: Mexico, Mexico City.

Distribution: Mexico.

In his description of this species, Busck did not mention the number of specimens he had before him. In the U.S. National Museum collection there are four specimens from Mexico: one ♀ marked "TYPE" in Busck's handwriting; one ♀ marked "Cotype" and a ♂ and ♀, the latter from Tehuacan, with red "cotype" labels. All bear USNM type number 22307 and all have a small white label with the number 3958.

The type and first cotype indicated above are conspecific, but the third and fourth specimens, the ♂ and the ♀ from Tehuacan, are what was described as *Hysterosia perspicuana* Barnes and Busck, from Arizona. The known range of *perspicuana* is thus extended into Latin America.

***Hysterosia iodes*, new species**

FIGURE 2; PLATE 1 (FIG. 3)

Alar expanse 28 mm.

Labial palpus fuscous, the scales laterally sparsely white tipped, and strongly so dorsally on second segment. Antenna ochraceous buff with fuscous scaling dorsally at base; scape fuscous. Head and thorax

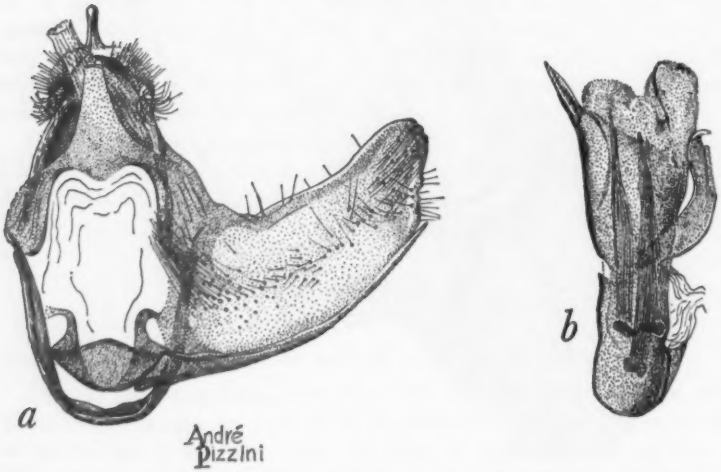


FIGURE 2.—*Hysterosia iodes*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

fuscous with a sprinkling of white-tipped scales; posterior tuft of thorax with mixture of reddish-brown and white-tipped scales. Forewing ground color grayish fuscous, much of the area overlaid with violaceous-metallic scales; on inner angle a narrow, longitudinal, ferruginous dash; at basal fifth an inwardly oblique, blackish-fuscous patch to fold, then outwardly to dorsum; from middle of costa, to dorsum at basal third, a blackish-fuscous transverse band, strongest about midway across wing; at end of cell a small, blackish-fuscous spot; slightly beyond end of cell, obliquely, a blackish-fuscous transverse band extends nearly to tornus; from apical third of costa a blackish-fuscous transverse band, broadest at vein 7, extends to and narrows at tornus; along costa several small patches of white-tipped scales; cilia fuscous. Hindwing ocherous white, heavily mottled with fuscous; cilia grayish fuscous with a very narrow, lighter, basal line. Foreleg pale ochraceous buff; femur and tibia strongly overlaid with fuscous exteriorly; tarsal segments almost wholly fuscous. Midleg similar to foreleg but not so strongly marked with fuscous; hindleg ochraceous buff with slight fuscous irroration and small fuscous patches at tibial spurs. Abdomen dull buff, suffused and irrorate with fuscous.

Male genitalia slide JFGC no. 11622. Harpe subrectangular; cucullus bluntly pointed; ventral edge of harpe produced into a slender pointed process before cucullus. Transtilla with long, smooth, median process. Uncus curved, slender. Vinculum evenly rounded, coalesced. Tegumen about two-thirds the length of harpe. Anellus a strongly sclerotized, curved, oval plate. Aedeagus stout, distally terminating in a sharp point ventrally; dorsally, from about middle, a long, curved process; cornuti, three long, closely compact, clusters of spines.

Holotype: U.S. National Museum No. 69729.

Type-locality: Guatemala, Volcan Santa Maria.

Distribution: Known only from the type-locality.

Described from the unique male holotype (Schaus and Barnes, "10.").

This species resembles the North American *Hysterosia birdana* Busck but lacks the unbroken, dark apical area of that species; moreover, the median portion of the transtilla of *birdana* is broad and armed with numerous, small, dentate processes, the cornuti are one or two, and the aedeagus lacks the long, curved, dorsal process of *iodes*.

Hysterosia turialba Busck

FIGURE 3; PLATE 1 (FIG. 1)

Hysterosia turialba Busck, 1920, Ins. Insc. Mens., vol. 8, nos. 4–6, p. 86.

Male genitalia slide AB Dec. 21, 1925. Harpe triangular; cucullus pointed; costa moderately sclerotized; from base of sacculus a long, irregular, sclerotized arm, free at distal extremity and ornamented with short ridges on each side. Uncus broad, divided, each lateral element terminating in a sharp point; socii recurved, slender. Vinculum

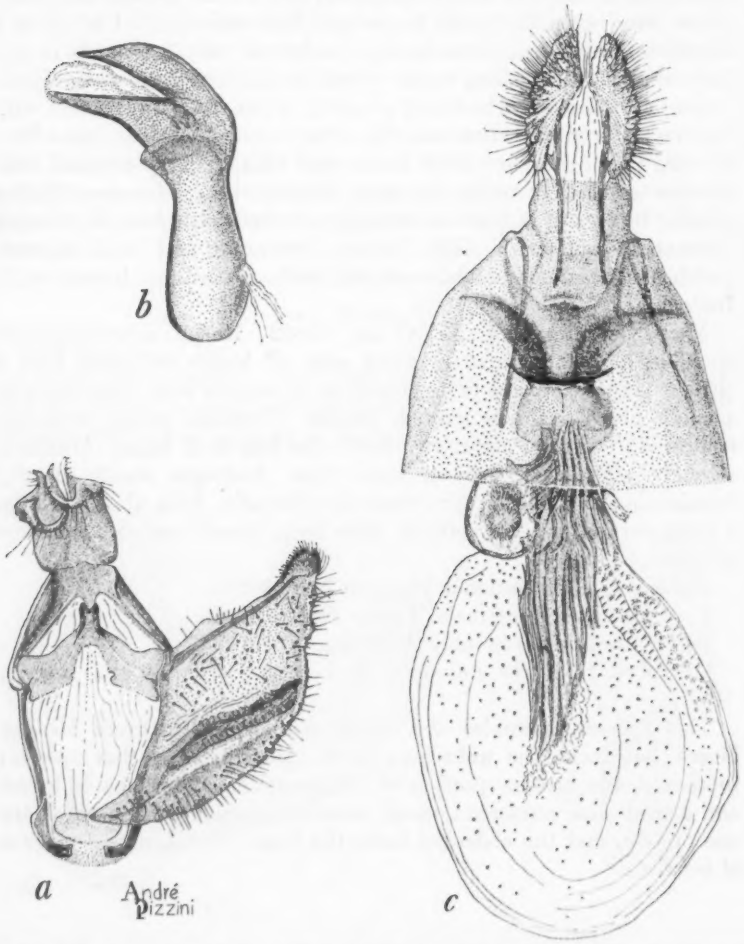


FIGURE 3.—*Hysterosia turialba* Busck: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

not coalesced. Tegumen short, about half the length of harpe. Anellus a broad, oval, sclerotized plate. Aedeagus stout, curved, with a dorsodistal, pointed, curved element and a pointed ventrodistal part expanded basally as a flat plate.

Female genitalia slide AB Dec. 2, 1925. Ostium transverse, narrow, ventral lip slightly concave; lamella antevaginalis heavily sclerotized laterally. Antrum broad, flattened, sclerotized. Inception of ductus seminalis posterior, from a depressed area within a sclerotized ring in side of bursa copulatrix. Ductus bursae ribbed, short. Bursa copulatrix ribbed posteriorly, the ribs confluent with those of ductus bursae.

Type: U.S. National Museum.

Type-locality: Costa Rica, Juan Vinas.

Distribution: Costa Rica, Guatemala.

Busck's type is a ♀ from Juan Vinas as indicated in the original description. There are three other specimens (2 ♀♀, Turrialba, Costa Rica, Wm. Schaus; ♂, Volcan Santa Maria, Guatemala, Schaus and Barnes) not mentioned by Busck, which are marked "Cotype." Presumably these three were before Busck when he described the species and are, therefore, paratypes, not cotypes. In addition, there is another specimen, ♀, from Volcan Santa Maria, Guatemala.

The name of this species is a misspelling of Turrialba.

The illustrations of this species are presented for comparative purposes because the species has not been figured previously.

***Hysterosia alphitopa*, new species**

FIGURE 4; PLATE 1 (FIG. 2)

Alar expanse 22–26 mm.

Labial palpus creamy white; second segment with ocherous-buff scaling basally on outer side. Antenna gray with white scaling dorsally at base of shaft; scape creamy white. Head creamy white with slight grayish-ocherous suffusion. Thorax creamy white; anteriorly burnt sienna; dorsally, two irregular but conspicuous black spots. Forewing ground color gray, basal third pale, ochraceous buff; at end of cell, and at extreme base of wing small, but conspicuous, yellow spots of raised scales; inner angle yellow; costa, to middle, broadly fuscous marked by dashes of leaden-metallic scales; beyond the fuscous basal portion a conspicuous, large, white blotch with a distinct black spot on costa at center of blotch; from the outer edge of the costal white blotch, at about vein 8, an oblique, outwardly curved, ocherous-white line extends to termen at vein 4, is preceded inwardly by an irregular patch of burnt sienna, the latter to tornus, with two small, black dashes costad, and followed by an irregular, outwardly oblique, blackish band, this bounded by narrow lines of metallic scales; at apex

and around termen, a series of burnt sienna spots; between dorsum and fold, at about basal third, a triangular burnt sienna spot with two small black spots costad; underside strongly overlaid with blackish fuscous, except whitish outer half of costa, the latter with several blackish spots; cilia burnt sienna mixed with gray and ochraceous buff. Hindwing gray strongly mottled with fuscous, in female almost wholly fuscous; cilia gray with darker subbasal line. Foreleg blackish fuscous outwardly with scattered white scales; inwardly creamy white; midleg femur white, irrorate with fuscous; tibia and tarsus fuscous, narrowly banded with whitish; hindleg creamy white, blotched and irrorate with fuscous. Abdomen fuscous dorsally, creamy white ventrally, speckled with fuscous.

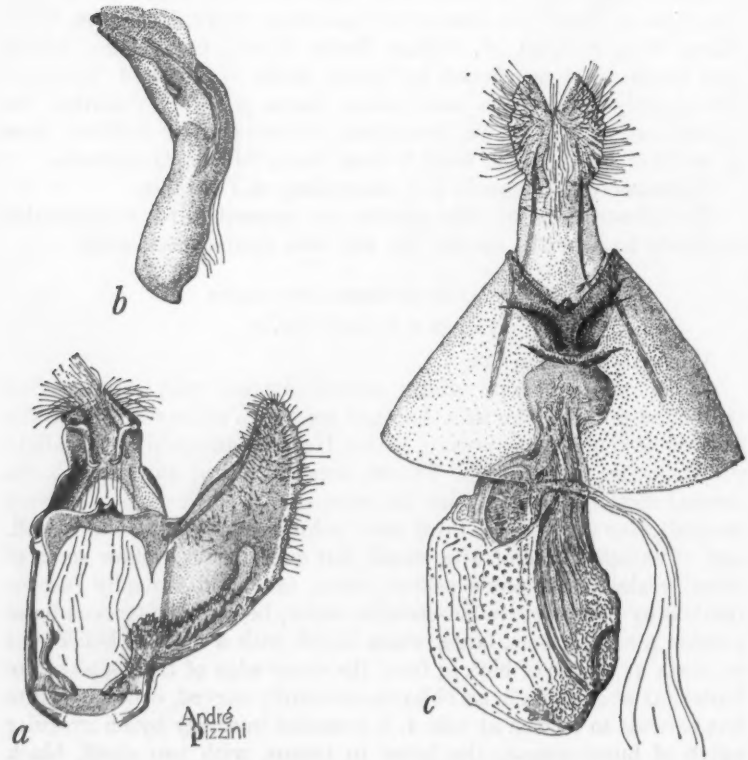


FIGURE 4.—*Hysterosia alphitopa*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

Male genitalia slide JFGC no. 11612. Harpe broad, saccular process extending to about half the length of harpe; posterior edge of process strongly setaceous. Uncus broad, divided into two flat elements, each terminating in a curved point. Vinculum narrow, lateral elements not coalesced in middle. Tegumen about half the length of harpe. Anellus cup shaped. Aedeagus stout, curved, with a long, narrow, dorsodistal projection.

Female genitalia slide JFGC no. 11613. Antrum strongly sclerotized. Inception of ductus seminalis from a fovea in posterior part of bursa copulatrix. Ductus bursae very short, broad. Bursa copulatrix strongly rugose on right side. Signum absent. Ostium broad, slitlike, transverse. Lamella antevaginalis moderately sclerotized; lamella postvaginalis with two strongly sclerotized lateral areas.

Holotype: U.S. National Museum No. 69730.

Type-locality: Venezuela, Aragua, Rancho Grande, 1100 m.

Distribution: Known only from the type-locality.

Described from the male holotype (16–23.X.66. S. S. and W. D. Duckworth), 5 ♂♂ and 1 ♀ paratypes with same locality and dates, from 16–31.X.66.

This taxon is strikingly similar to *turialba* but is a smaller insect with more strongly mottled hindwings. The saccular process of *alphitopa* is much shorter than that of *turialba* and the aedeagus is much more slender (see figs. 3, 4). The two lateral, sclerotized areas of the lamella postvaginalis of *turialba* are larger and the rugose portion of the bursa copulatrix is smaller than in *alphitopa*.

Hysterosia melasma, new species

FIGURE 5; PLATE 1 (FIG. 4)

Alar expanse 22–24 mm.

Labial palpus white; second segment fuscous ventrally and apically and irrorate with fuscous; third segment fuscous on outer side. Antenna gray, suffused with fuscous basally. Head mixed gray and sordid white. Thorax gray, irrorate with fuscous; tegula tipped with white; posterior tuft with white scales mixed. Forewing ground color gray, transversely marked with numerous fine, fuscous strigulae; from costal two-fifths, obliquely to inner angle, a straight, narrow, whitish line; from apical third of costa, a transverse, triangular whitish patch extends to center of wing; between this and the basal whitish line, a black, longitudinal dash; from apical third of costa, and confluent with the tip of the triangular patch, a double, narrow, whitish, transverse line extends outwardly to vein 3, then turns inwardly to tornus; outer edge of this pale line bordered with a very thin line of fuscous; subapically, a whitish line extends around termen; underside of costa spotted with white; cilia gray basally, white apically. Hind-

wing whitish, strongly mottled with grayish fuscous; cilia gray basally, white apically. Foreleg ocherous white, overlaid with fuscous; hindleg ocherous white, suffused and irrorate with grayish fuscous, particularly on outer side. Abdomen ocherous white with grayish-fuscous suffusion and irroration.

Male genitalia slide JFGC no. 11623. Harpe moderately broad, cucullus rounded; sacculus very broad basally and heavily sclerotized, terminating in a sharp point. Uncus rather short, compressed, sharply pointed. Vinculum evenly rounded, narrow. Tegumen short, stout. Transtilla terminating in a median, stout, strongly spined process. Anellus subrectangular, broader than long. Aedeagus stout, distally terminating in a sharp, slightly curved, point; vesica armed with two long and two short cornuti.

Holotype: U.S. National Museum No. 69731.

Type-locality: Guatemala, Chejel.

Distribution: Guatemala.

Described from the male holotype (June, Schaus and Barnes) and 3 ♂♂ paratypes, all with the same data. Male genitalia figured from the holotype.

Apparently *melasma* is closely related to *H. perspicuana* Barnes and Busck but is immediately distinguished from it by the four cornuti, there being only three in *perspicuana*. The uncus of *melasma* is less than half the length of that of *perspicuana* and the sacculus is much wider.

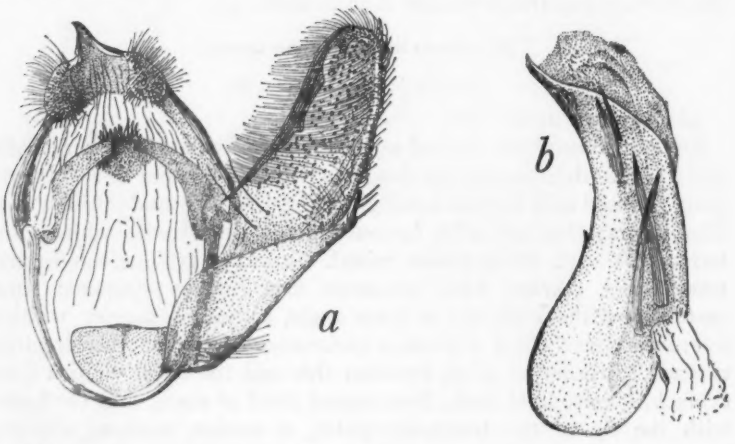


FIGURE 5.—*Hysterosia melasma*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

Phalonia Hübner

Phalonia embrithopa Meyrick

PLATE 1 (FIGS. 6, 7)

Phalonia embrithopa Meyrick, 1927, Exotic Microlepidoptera, vol. 3, p. 366.—Clarke, 1963, Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick, vol. 4, p. 27, pl. 13, figs. 1–1a.

Meyrick described *embrithopa* from three specimens stated by him to be females. One specimen has disappeared but the remaining two, the lectotype and a paralectotype, the latter before me, are males. In addition to these, I have three males from Colombia that are obviously this species but that are atypical. For two of these specimens I append the following description.

Alar expanse 26–28 mm.

Labial palpus clay color; first segment with conspicuous fuscous spot exteriorly; third segment mixed with fuscous. Antenna clay color; scape infuscated distally. Head light clay color. Thorax and tegula light clay color; posterior tuft fuscous mixed with sordid white. Forewing ground color sordid white, heavily overlaid and strigulated with tawny olive; from basal third of costa, obliquely to inner angle, a tawny-olive line delimiting a mixed tawny-olive and whitish basal patch; on middle of costa a tawny-olive spot continued indistinctly and transversely to cell, then obliquely and inwardly to dorsum; apical fourth tawny olive mixed with white and fuscous scales; at end of cell, between veins 2 and 4, an outwardly oblique, indistinct fuscous blotch extends to tornus; on dorsal edge a series of fuscous spots; underside strongly infuscated except apical two-fifths of costa; cilia sordid white mixed with gray, fuscous, and tawny olive. Hindwing sordid white, transversely striated and mottled with grayish fuscous, underside more strongly so; cilia whitish mixed with gray. Foreleg ocherous white strongly overlaid with fuscous outwardly; midleg similar to foreleg but banded with tawny olive; hindleg ocherous white suffused and irrorate with fuscous. Abdomen clay color infuscated ventrally.

These two, from Páramo de Puracé, are larger than the two remaining Meyrick types and the pattern of the forewing is less blotched and the reticulations are finer. The basal patch and median transverse fascia are more pronounced. The hindwing of the original *embrithopa* is darker and the mottling is heavier than in the two from Páramo de Puracé. The third additional specimen from Volcan Galeras is smaller than the types (22 mm) and the forewing is paler in color. The hindwing of this specimen is intermediate between the originals and the two from Páramo de Puracé.

All of the specimens are from high altitudes. Mt. Tolima (3846 m), Páramo de Puracé (3570 m) and Volcan Galeras (2900 m). The differences in altitude are not great but may well account for the variation that exists. All of the specimens are indistinguishable on genitalia.

Type: British Museum (Natural History).

Type-locality: Colombia, Mt. Tolima.

Distribution: Colombia: 2 ♂♂, Mt. Tolima; 2 ♂♂, Cauca, Páramo de Puracé, Lake San Rafael, 3570 m, 27.I.1959, J. F. G. Clarke; ♂ Nariño, Volcan Galeras, 2900 m, 13.I.1959, J. F. G. Clarke.

***Phalonia tornosema*, new species**

FIGURE 6; PLATE 2 (FIG. 7)

Alar expanse 12–13 mm.

Labial palpus white; basal half of second segment fuscous on outer side; third segment with a few scattered fuscous scales. Antenna fuscous; scape white except fuscous apex. Head white with grayish scales laterally. Thorax gray, mixed with russet and fuscous; anterior margin narrowly white; posterior tuft ochraceous orange. Forewing ground color pale gray; on each side of fold a series of four (total 8) round spots of mixed russet and leaden gray scales; on tornus a conspicuous ochraceous-orange spot; basal patch indistinct, indicated mostly by ochraceous-tawny scales; inner angle fuscous; from middle of costa an ill-defined, brown, transverse fascia with a small fuscous spot on each edge in cell; beyond this fascia a costal whitish area followed by short, transverse whitish and russet fasciae; underside grayish fuscous except from fold to dorsal edge; cilia light tawny mixed with gray, lighter around tornal area. Hindwing grayish fuscous; cilia light grayish with darker sub-basal band. Foreleg sordid white strongly infuscated on outer side; tarsus banded with fuscous; midleg similar to foreleg; hindleg ocherous white; tibial spurs and tarsus minutely spotted with fuscous. Abdomen grayish fuscous dorsally; ocherous white ventrally, irrorate and suffused with fuscous.

Female genitalia slide JFGC nos. 11223, 11630. Ostium transverse, narrow. Antrum sclerotized in a narrow band. Inception of ductus seminalis from anterior end of bursa copulatrix; accessory bursa from near inception of ductus seminalis. Ductus bursae very short, about one-third the length of bursa copulatrix. Bursa copulatrix membranous. Signum absent. Lamella antevaginalis and lamella postvaginalis very lightly sclerotized.

Holotype: U.S. National Museum No. 69740.

Type-locality: Guatemala, Volcan Santa Maria.

Distribution: Guatemala.

Described from the female holotype and seven ♀♀ paratypes all

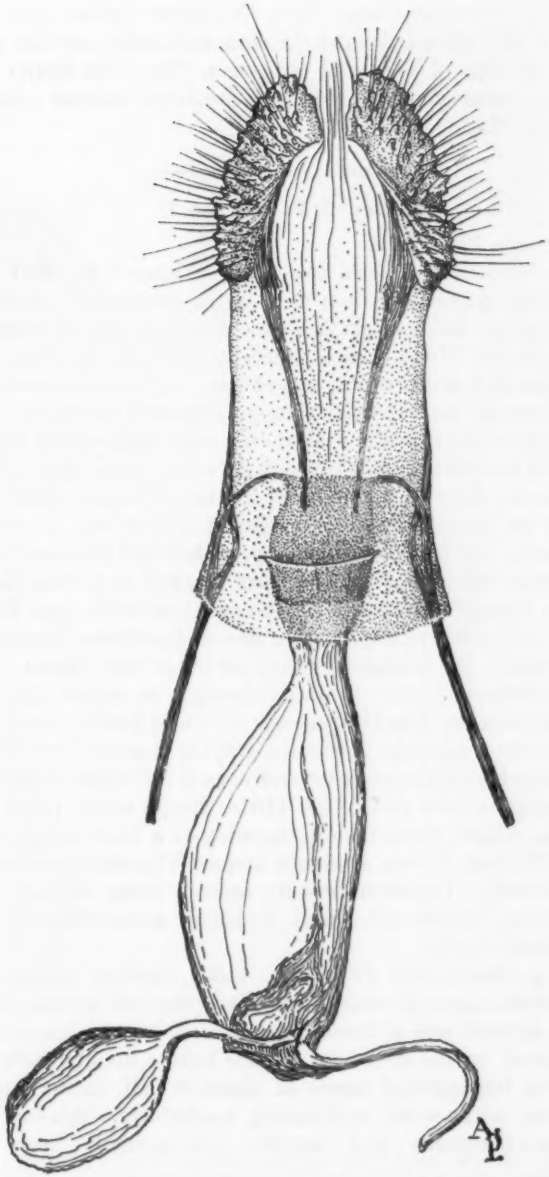


FIGURE 6.—*Phalonia tornosema*, new species: ventral view of female genitalia.

from the type-locality (June, July, November; Schaus and Barnes).

Under *vesta* I have indicated the close similarity, and the apparent close relationship of *vesta* and *tornosema*. The eight round spots of leaden gray scales on the forewing of *tornosema* are not apparent on the forewing of *vesta*.

***Phalonia vesta*, new species**

FIGURE 7; PLATE 4 (FIG. 7)

Alar expanse 12–13 mm.

Labial palpus white; basal two-thirds of second segment strongly overlaid with grayish fuscous; third segment sparsely irrorate with grayish fuscous. Antenna grayish fuscous; scape white, irrorate with grayish fuscous. Head white, laterally suffused grayish. Thorax grayish, mottled with white, russet and ochraceous-tawny scales. Forewing ground color grayish, largely obscured by tawny, grayish-fuscous and leaden-metallic scales; on costa, three russet bars alternating with leaden-metallic, transverse fasciae; inner angle narrowly marked black; along fold a series of scattered black scales; at costal two-thirds an ill-defined whitish area; at end of cell a conspicuous elongate, oval, ocherous-white spot preceded and followed by black scales; tornus ochraceous orange; apex marked by several ill-defined transverse, russet fasciae; cilia clay color mixed with gray. Hindwing grayish fuscous; cilia pale gray with darker basal line. Foreleg sordid white overlaid with blackish fuscous on outer side; tarsal segments with only narrow bands of white showing on outer side; midleg similar but with less blackish fuscous on tibia; hindleg sordid white, faintly irrorate with gray. Abdomen grayish fuscous dorsally, sordid white, suffused with cinereous ventrally; anal tuft light ocherous gray.

Male genitalia slide JFGC no. 11638. Harpe about twice as long as tegumen, widest about middle, tapering to a blunt point; sacculus slightly thickened. Uncus a minute nodule. Vinculum not coalesced, narrow laterally. Tegumen broadly arched, dome shaped. Anellus subrectangular, lightly sclerotized. Aedeagus rather slender, curved; vesica without cornuti.

Female genitalia slide JFGC no. 11639. Ostium narrow, transverse. Antrum narrowly sclerotized. Inception of ductus seminalis from near anterior end of bursa copulatrix; accessory bursa adjacent to inception of ductus seminalis. Ductus bursae mainly membranous with narrow longitudinal ridges in anterior half. Bursa copulatrix membranous with weak sculpturing posteriorly. Signum absent. Lamella antevaginalis and lamella postvaginalis very lightly sclerotized.

Holotype: U.S. National Museum No. 69755.

Type-locality: Venezuela, Aragua, Rancho Grande, 1100 m.

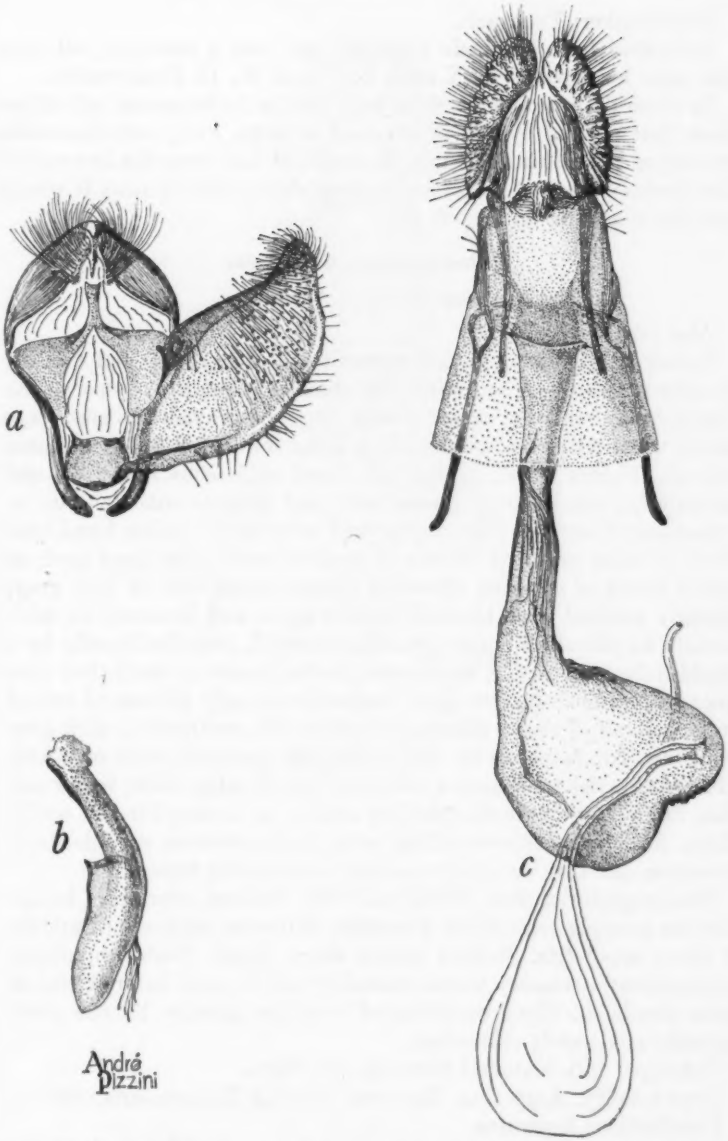


FIGURE 7.—*Phalonia vesta*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

Distribution: Venezuela.

Described from the male holotype, and one ♀ paratype, all from the same locality (16–23.X.1966, S. S. and W. D. Duckworth).

In general appearance *vesta* is very similar to *tornosema* but differs from that species by the presence of a large, oval, ocherous-white spot at end of cell in forewing. No males of *tornosema* are known but the ductus bursae of *tornosema* is very short; that of *vesta* is nearly four times as long (cf. figs. 6, 7).

***Phalonia charma*, new species**

FIGURE 8; PLATE 3 (FIG. 7)

Alar expanse 14 mm.

Labial palpus white; second segment suffused grayish and sparsely irrorate with fuscous on outer side; third segment with fuscous dash dorsally and ventrally on outer side. Antenna grayish fuscous; scape sordid white with fuscous irroration. Head sordid white; face suffused grayish. Thorax sordid white with band of fuscous anteriorly and posteriorly; tegula fuscous anteriorly and irrorate with fuscous on remainder of surface. Forewing ground color sordid white; basal two-fifths of costa gray; on middle of costa a rectangular gray spot; at apical fourth of costa an olive-buff blotch; apical fifth of wing gray, strongly marked with blackish-fuscous spots and blotches; on mid-dorsum an olive-buff shade extending into cell, preceded basally by a blackish-fuscous blotch; on dorsum, before tornus a small, but conspicuous, blackish-fuscous spot; underside strongly infuscated except on apical half of costa; cilia sordid white with contrasting, dark gray basal line. Hindwing sordid white with pale grayish-fuscous mottling; cilia pale grayish with darker subbasal line. Foreleg white; femur and tibia fuscous on outer side; midleg similar to foreleg; hindleg sordid white. Abdomen ocherous white with grayish-fuscous suffusion and irroration dorsally; ventrally sparsely irrorate with fuscous.

Female genitalia slide JFGC no. 11634. Ostium crescentic, broad. Antrum strongly sclerotized. Inception of ductus seminalis at middle of bursa copulatrix. Ductus bursae short, broad. Bursa copulatrix membranous; accessory bursa extending well beyond anterior end of bursa copulatrix. Signa consisting of very fine spicules; lamella post-vaginalis moderately sclerotized.

Holotype: U.S. National Museum No. 69744.

Type-locality: Argentina, Tucumán, Ciudad Universitaria, 800 m.

Distribution: Argentina.

Described from the unique female holotype (17.II.59. J. F. G. Clarke).

In general aspect *charma* is similar to the North American *Phalonia glaucofuscana* (Zeller), but the terminal dark area of *charma* is less

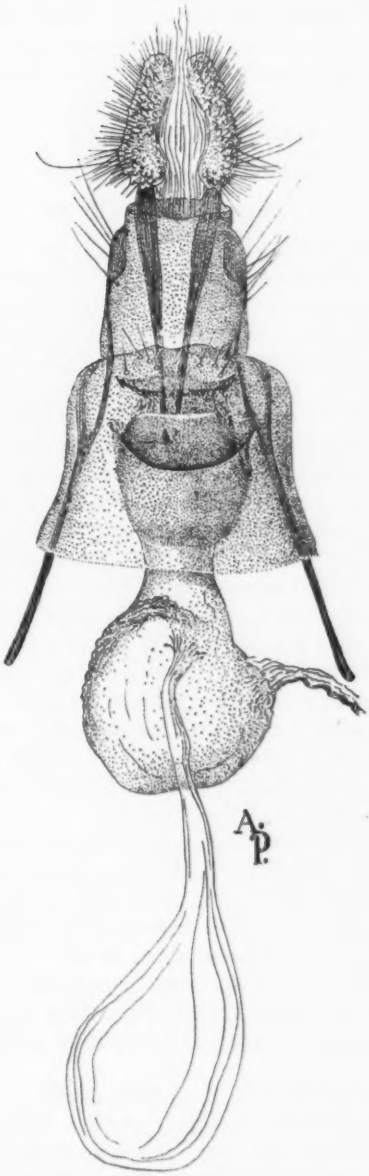


FIGURE 8.—*Phalonia charma*, new species: ventral view of female genitalia.

extensive than in *glaucofuscana* and the hindwing of the former is much lighter than that of the latter. The actual affinities of *charma* are not clear but the broad ostium and short ductus bursae characterize this species.

Cochylis Treitschke

Cochylis caesiata, new species

FIGURE 9; PLATE 3 (FIG. 4)

Alar expanse 10–12 mm.

Labial palpus ochraceous buff; second segment sparsely irrorate with fuscous; third segment with slight infuscation. Antenna grayish fuscous; scape buff. Head buff; laterally, scales slightly darker. Thorax buff, posteriorly a few tawny scales; tegula light clay color anteriorly. Forewing ground color buff; basal two-fifths clouded with clay color; across middle of wing a broad, leaden-gray, transverse band variously marked with brown and fuscous; within this broad band, from dorsum, along inner side of band, a large blackish-fuscous patch extending two-thirds distance to costa; outer margin of median band narrowly edged with brown; along extreme costal edge a series of small blackish dots, the last slightly before apex; subterminal pale area with a few scattered brown scales; underside with broad grayish-fuscous median band; terminal area tawny; cilia buff. Hindwing ocherous white basally, followed by a grayish fuscous band; subterminal and apical areas light tawny. Foreleg buff, irrorate and shaded with fuscous; midleg buff, femur and tibia each with a proximal and distal blotch of fuscous; first tarsal segment with fuscous spot, remaining segments with scattered fuscous scales. Hindleg buff, tarsal segments slightly more ochraceous. Abdomen pale grayish dorsally; ventrally buff with a median longitudinal line of fuscous spots.

Female genitalia slide JFGC no. 11614. Ostium very broad, convex; anterior edge armed with sharp teeth. Inception of ductus seminalis at middle of bursa copulatrix, from an alveole at the anterior end of a sclerotized bar, the latter with one crenulate edge. Ductus bursae very short, hardly differentiated from bursa copulatrix; accessory bursa from posterior edge of bursa copulatrix. Bursa copulatrix membranous with spiculate inner surface. Signum absent. Lamella antevaginalis depressed, sclerotized; lamella postvaginalis lightly sclerotized.

Holotype: U.S. National Museum No. 69742.

Type-locality: Venezuela, Aragua, Rancho Grande, 1100 m.

Distribution: Known only from the type-locality.

Described from the female holotype (16–23.X.66. S. S. and W. D. Duckworth) and two ♀♀ paratypes, all from the type-locality. Paratypes dated 11–19.I.66.

FIGURE 9.—*Cochylis caesiata*, new species: ventral view of female genitalia.

In appearance quite similar to *Euxanthis amphimnesta* Meyrick, from Kumaon, but the median fascia of *caesiata* is broader and the tricolored hindwing immediately distinguishes the latter from the former. In female genitalia *caesiata* is nearest the North American *C. hospes* Walsingham.

***Cochylis serena*, new species**

FIGURE 10; PLATE 4 (FIG. 6)

Alar expanse 15–17 mm.

Labial palpus white; second segment irrorate with fuscous on outer side; third segment suffused fuscous apically. Antenna grayish fuscous; basal fifth black dorsally; scape white. Head white with some gray scaling posterolaterally. Thorax gray, mixed with fuscous and leaden-metallic scales; tegula whitish to gray mixed with fuscous. Forewing ground color white; basal three-fifths fuscous mixed with leaden gray and tawny; in some specimens the basal dark area becomes attenuated so that dorsum is almost wholly white; on costal edge of cell, near middle of wing, two black spots and a third black spot beyond end of cell; from outer fifth of costa a crescentic, gray fascia to vein 4 at termen; on termen from vein 4 to vein 2 a narrow, tawny, transverse fascia; apical sixth of wing marked with several irregular strigulae and spots of mixed gray, fuscous and tawny; underside fuscous except a costal area at two-thirds; cilia ochraceous buff with a strong gray basal line around apex and termen. Hindwing sordid white mottled with grayish fuscous in male; in female grayish fuscous, the darker mottling ill-defined; cilia ocherous white with gray subbasal line. Foreleg ocherous white; femur and tibia blackish fuscous on outer side; tarsal segments broadly banded blackish fuscous; midleg similar but not so strongly marked; hindleg ocherous white lightly suffused and irrorate with fuscous. Abdomen grayish fuscous dorsally somewhat paler ventrally; anal tuft ocherous white.

Male genitalia slide JFGC no. 11659. Harpe broad, tapering to a bluntly pointed cucullus. Transtilla with flattened dentate median process. Socii fleshy lobes. Vinculum narrow, lateral elements not coalesced. Tegumen a moderately narrow band. Anellus a broad sclerotized saucer-shaped plate. Aedeagus stout, acutely pointed; vesica armed with a single stout cornutus.

Female genitalia slide JFGC no. 11660. Ostium broad, anterior edge concave. Antrum moderately sclerotized. Inception of ductus seminalis ventrally from posterior third of bursa copulatrix; accessory bursa extending slightly beyond anterior end of bursa copulatrix. Ductus bursae short, broad with sclerotized ring near middle. Bursa copulatrix membraneous except an irregular area posteriorly.

Holotype: U.S. National Museum No. 69754.

Type-locality: Brazil, Santa Catharina, Nova Teutonia.

Distribution: Known from the type-locality only.

Described from the male holotype (VII.1963, F. Plaumann), 4 ♂♂ and one ♀ paratypes all from the same locality (June to December dates).

This species is nearly allied to the following *constantia*, but the apical third of the forewing of *serena* is whitish except for a narrow,

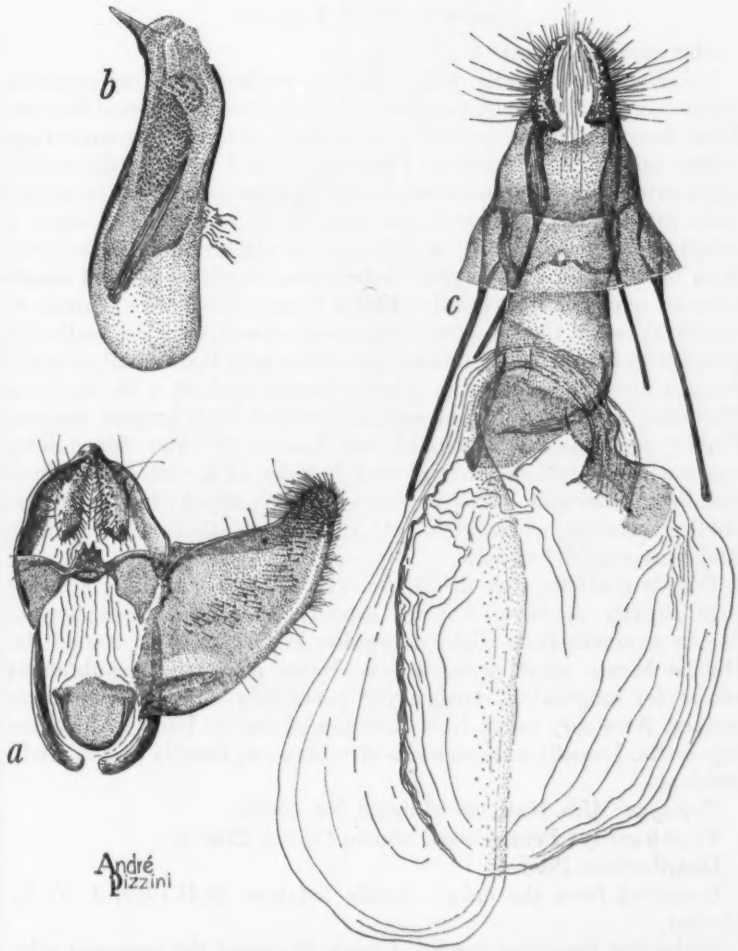


FIGURE 10.—*Cochylis serena*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

dark, subterminal line. In *constantia* only the extreme apex is white, the remaining part of the apical third is largely filled with fuscous and leaden-gray scales. The female genitalia of *constantia* show much more sculpturing and spining in the bursa copulatrix than is present in *serena*. No comparison of the male genitalia can be made because the male of *constantia* is unknown.

***Cochylis constantia*, new species**

FIGURE 11; PLATE 4 (FIG. 8)

Alar expanse 17 mm.

Labial palpus fuscous, paler on inner surface of second segment. Antenna grayish fuscous; scape sordid white strongly suffused fuscous. Head fuscous. Thorax mottled fuscous and pale gray; posterior edge white; apex of tegula white. Forewing ground color sordid white; basal patch ill-defined, indicated mainly by fuscous and gray mottling; costa marked by gray spots and short bars; at middle of costa a subquadrate, gray blotch; on dorsal edge six small, fuscous spots; from mid-dorsum a large gray blotch extending into cell and superimposed over it an outwardly oblique fuscous band; from tornus to termen at vein 5, thence obliquely to costa before apex, a gray suffusion mixed with fuscous at its middle; apex white with three small, grayish-fuscous spots at edge; cilia grayish fuscous mixed with cinerous. Hindwing sordid white contrastingly mottled with grayish fuscous. Foreleg ocherous white overlaid with fuscous on outer side; midleg ocherous white suffused with grayish fuscous; tibia with fuscous spot distally on outer side; tarsal segments narrowly edged whitish distally; hindleg ocherous white with only slight suggestion of infuscation. Abdomen grayish fuscous.

Female genitalia slide JFGC no. 11593. Ostium slitlike; anterior edge slightly concave. Antrum broadly sclerotized. Inception of ductus seminalis from slight depression in side of bursa copulatrix. Ductus bursae short, membranous. Bursa copulatrix membranous except for longitudinal sculpturing posteriorly and spiculate inner surface. Accessory bursa from juncture of ductus bursae and bursa copulatrix. Lamella antevaginalis membranous; lamella postvaginalis scobinate.

Holotype: U.S. National Museum No. 69756.

Type-locality: Peru, Cusco, Machu Picchu, 2700 m.

Distribution: Peru.

Described from the unique female holotype (6.II.1959, J. F. G. Clarke).

Under the foregoing, *serena*, I have discussed the apparent relationship of the two species, but much additional material will be required before a proper alignment can be made.

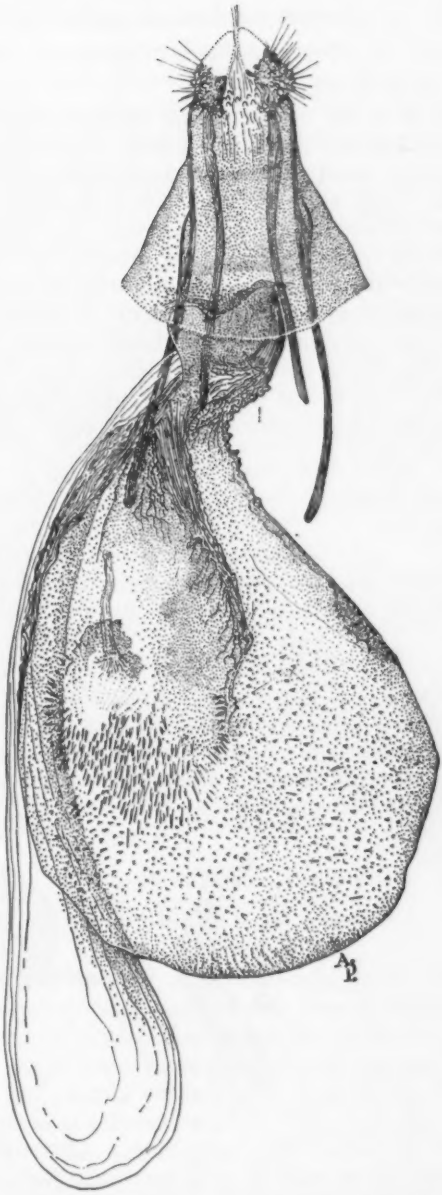


FIGURE 11.—*Cochylis constantia*, new species: ventral view of female genitalia.

***Cochylis mendora*, new species**

FIGURE 12; PLATE 3 (FIG. 2)

Alar expanse 14–15 mm.

Labial palpus sordid white; second segment tinged ocherous on outer side; third segment tipped with fuscous. Antenna grayish fuscous; scape sordid white. Head sordid white tinged with ocherous posteriorly. Thorax sordid white, sparsely irrorate with brownish and ocherous; tegula fuscous anteriorly. Forewing ground color sordid white; base of costa narrowly fuscous, followed by several small dots and a bar of the same color at middle; basal fifth of wing light clay color forming an ill-defined basal patch; from middle of dorsum to middle of cell, a broad, outwardly oblique brown fascia followed at outer end by a clay-colored shade; on dorsum, four fuscous spots, the larger of the four astride the base of the transverse fascia; subterminally a clay-colored transverse shade; extreme terminal edge marked with clay

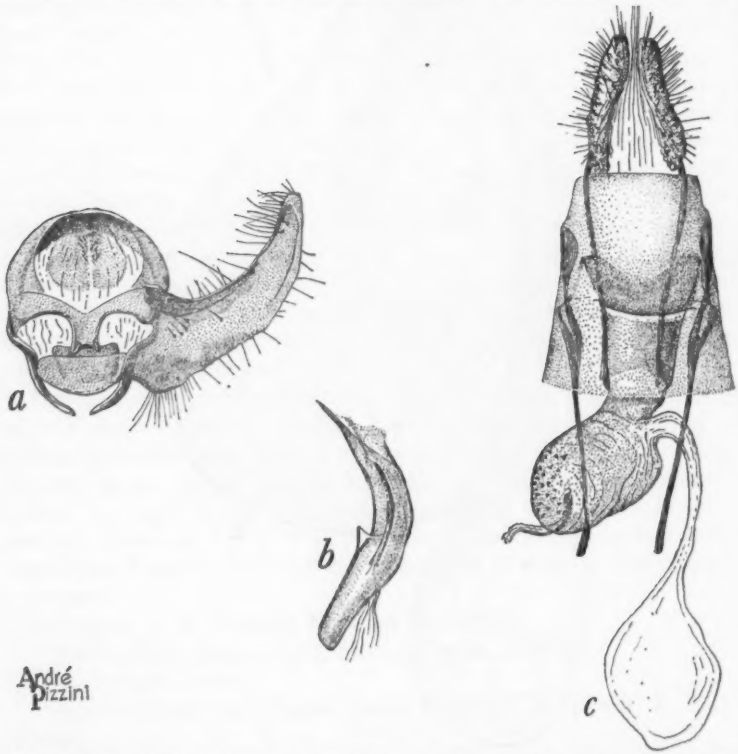


FIGURE 12.—*Cochylis mendora*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

color; underside, except costal two-fifths, fuscous; cilia white mixed with clay color and fuscous. Hindwing grayish fuscous, lighter basally; cilia pale gray with darker subbasal line. Foreleg ocherous white; femur and tibia shaded with fuscous on outer side; midleg similar to foreleg; hindleg ocherous white. Abdomen grayish fuscous dorsally, ocherous white ventrally.

Male genitalia slide JFGC no. 11632. Harpe slender; cucullus narrow, bluntly pointed; base of sacculus dilated. Vinculum very narrow, but coalesced medially. Tegumen broad, rounded, Anellus a broad, concave plate. Aedeagus moderately stout, curved, sharply pointed; vesica armed with a single, long, slender cornutus.

Female genitalia slide JFGC nos. 11633, 11217. Ostium wide; ventro-anterior lip concave. Antrum broadly sclerotized. Ductus seminalis from anterior half of bursa copulatrix. Ductus bursae short, broad. Bursa copulatrix membranous; accessory bursa extending well beyond anterior end of bursa copulatrix. Signa many small spinules.

Holotype: U.S. National Museum No. 69743.

Type-locality: Chile, Santiago Prov., Cajon de Maypo, Cordillera, El Centro.

Distribution: Known only from Chile.

Described from the male holotype (12–20 Jan. 1948, Tito Ramirez), and one ♀ paratype with same data, and one ♀ paratype, El Principal (11.1888, V. Izquerdo).

In general appearance *mendora* is similar to the North American *Cochylis felix* (Walsingham) but is smaller, lighter, and lacks the dark subterminal spot of that species. The harpe of *felix* is more evenly rounded and broader ventrally than that of *mendora* and the aedeagus is stouter. The ostium of *mendora* is twice as broad as that of *felix* and the spining of the bursa copulatrix is much less extensive than in the latter.

Cochylis laetitia, new species

FIGURE 13; PLATE 3 (FIG. 3)

Alar expanse 15 mm.

Labial palpus ocherous white, light ochraceous buff on outer side; second segment sparsely irrorate with grayish basally. Antenna pale grayish buff; scape with grayish-fuscous irrorations. Head ocherous white with slight, pale infuscation. Thorax ocherous white, suffused ochraceous buff; tegula ochraceous buff anteriorly. Forewing ground color buff; costa and dorsum marked with small grayish-fuscous spots; at basal two-fifths a triangular yellow-ocher spot astride fold; a similarly colored triangular spot, its base on dorsum slightly beyond middle, extending to fold; in apical third several ill-defined transverse fasciae composed of narrow yellow-ocher spots and the whole

area finely irrorate with grayish fuscous; underside lightly mottled with grayish fuscous; cilia mixed gray and yellow ocher with dark gray basal line. Hindwing sordid whitish mottled with grayish fuscous; cilia ocherous white with gray subbasal line. Foreleg ocherous white; femur and tibia overlaid with fuscous on outer side; tarsal segments broadly banded with grayish fuscous; midleg similar to foreleg; hindleg ocherous white; femur sparsely irrorate with grayish fuscous. Abdomen pale buff; dorsally suffused with grayish fuscous; ventrally with slight, fuscous, median irroration.

Male genitalia slide JFGC no. 11635. Harpe triangular, broad basally, tapering to a pointed cucullus. Vinculum coalesced, with median point. Tegumen rounded, broad. Anellus a broad, sclerotized plate. Aedeagus moderately stout, sharply curved at distal third, sharply pointed; vesica armed with a single, slightly curved, slender cornutus.

Holotype: U.S. National Museum No. 69745.

Type-locality: Argentina, Tucumán, Ciudad Universitaria, 800 m.

Distribution: Known only from the type-locality.

Described from the unique male holotype (20.II.59, J. F. G. Clarke).

Similar to *Phalonia sublimis* Meyrick from Peru, but lacking the contrasting transverse fascia of the forewing of that species.

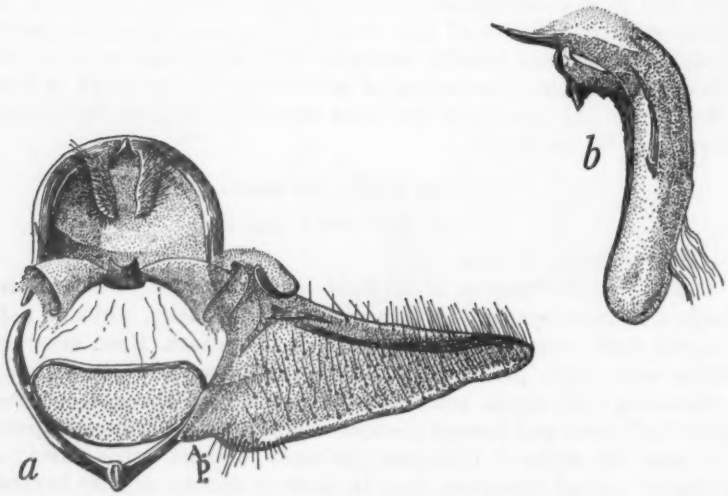


FIGURE 13.—*Cochylis laetitia*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

Amallectis Meyrick

Amallectis nephelodes, new species

FIGURE 14; PLATE 2 (FIG. 3)

Alar expanse 16–21 mm.

Labial palpus creamy white overlaid with ocherous buff on outer side; second segment infuscated basally. Antenna grayish fuscous; scape fuscous. Head ocherous buff with grayish scales laterally; in female, head gray. Thorax brownish gray; apex of tegula grayish buff. Forewing ground color, light clay color in basal half, gray in apical half; basal third of wing overlaid with ochraceous buff; from basal

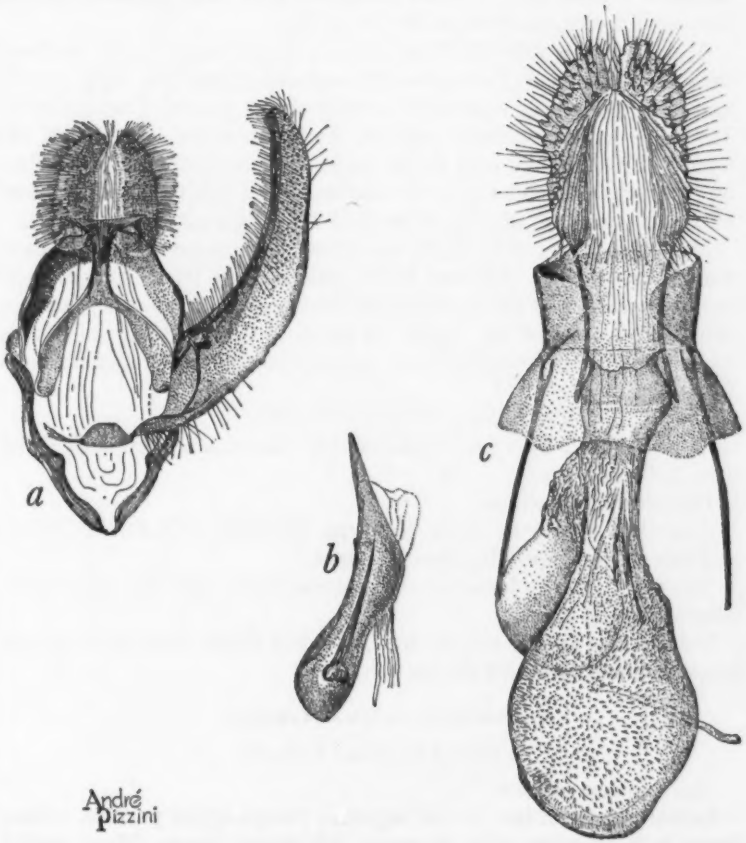


FIGURE 14.—*Amallectis nephelodes*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

third of dorsum to well beyond middle of cell, an outwardly oblique ochraceous-tawny, transverse band with fuscous scales at base and apex; beyond this fascia, on middle of dorsum, an elongate, transverse, grayish-olive patch with its apex near end of cell; on tornus a small fuscous spot; beyond end of cell a large, irregular, transverse, fuscous blotch followed by a curved line of ground color, the latter followed by a broadly crescentic, subapical, fuscous, transverse bar; cilia mixed ocherous, fuscous and gray. Hindwing grayish fuscous, somewhat paler basally. Foreleg ocherous buff strongly infuscated on outer side; midleg similar to foreleg but with less fuscous; hindleg ocherous buff lightly spotted with gray on femur and tibia; tarsal segments marked with blackish fuscous on outer side. Abdomen grayish fuscous dorsally, ocherous white ventrally.

Male genitalia slide JFGC no. 11625. Harpe long, slender, without ornamentation; cucullus narrowly rounded. Transtilla long, terminating in two widely separated, acutely sharp, points. Uncus absent. Vinculum narrow, bluntly pointed. Tegumen broad, about half the length of harpe; socii long fleshy lobes. Anellus subtriangular. Aedeagus moderately slender, apically flattened and pointed; vesica armed with one cornutus, slightly more than half the length of aedeagus.

Female genitalia slide JFGC no. 11626. Ostium small with concave ventro-anterior lip. Antrum broad, wider than long. Inception of ductus seminalis at about middle of ductus bursae; accessory bursa a rounded, sclerotized sac dorsal to bursa copulatrix. Ductus bursae wide, mostly membranous. Bursa copulatrix with finely granular surface. Signum absent.

Holotype: U.S. National Museum No. 69737.

Type-locality: Bolivia, Cochabamba, Incachaca, Tropical cloud area, 2100 m.

Distribution: Bolivia.

Described from the male holotype (27.VIII–5.IX.56. L. Peña), and one ♀ paratype with identical data.

The female is the larger of the two specimens and has paler hindwings than the male.

This species is near *anaxia* and *peñai* but differs from both by the larger size and generally darker color.

Amallectis peñai, new species

FIGURE 15; PLATE 2 (FIG. 2)

Alar expanse 14 mm.

Labial palpus white; second segment, except apical portion, ochraceous buff on outer side. Antenna ochraceous tawny. Head sordid white with some ochraceous-buff scales around eye. Thorax grayish fuscous; apex of tegula sordid white. Forewing ground color white

FIGURE 15.—*Amallectis peñai*, new species: ventral view of female genitalia.

(clearly visible only in apical area), heavily overlaid with ochraceous buff and olivaceous gray; basal half of costa ochraceous buff; from basal third of dorsum to cell, an oblique subrectangular blackish-fuscous and tawny patch bounded on each side with a narrow whitish line; basad of this shade an olivaceous shade parallels it and extends well into cell; beyond the dark dorsal mark a grayish shade, terminated by a few leaden scales, extends to tornus; on tornus a rounded, olivaceous spot extends to vein 6 and is bounded outwardly by ochraceous-tawny and blackish-fuscous scales; from apical third to termen at vein 4, an outwardly curved crescentic fascia, broadest in middle, shaded with ochaceous tawny on costa and edged with blackish fuscous in terminal half; on costa, on each side of the crescentic mark, a small patch of leaden scales; cilia buff with slightly darker basal band. Hindwing ocherous white basally shading to light ochraceous buff apically; cilia ocherous white becoming darker around apex. Foreleg ochraceous buff suffused with fuscous on outer side; midleg similar; hindleg buff. Abdomen ocherous white to buff, suffused with grayish.

Female genitalia slide JFGC nos. 11219, 11629. Ostium moderately broad, slitlike, anterior edge concave. Antrum broadly sclerotized. Ductus bursae nearly as long as bursa copulatrix with weak sculpturing in the form of longitudinal ridges. Bursa copulatrix membranous with weak sculpturing in posterior portion, the ridges confluent with those from ductus bursae; inner surface of bursa copulatrix clothed with very fine, weak spicules. Lamella antevaginalis and lamella postvaginalis membranous.

Holotype: U.S. National Museum No. 69734.

Type-locality: Bolivia, Cochabamba, Incachaca. Tropical cloud area, 2100 m.

Distribution: Bolivia and Peru.

Described from the female holotype (27.VIII. to 5.IX.56, L. Peña), and one ♀ paratype, Peru, Cusco, Machu Picchu, 2700 m. (6.II.59, J. F. G. Clarke).

This taxon is nearest *anaxia* and is discussed under that species.

It is with great pleasure that I dedicate this species to its collector, Mr. Luis Peña, who has contributed much material toward a better knowledge of the Neotropical microlepidopterous fauna.

Amallectis frangula, new species

FIGURE 16; PLATE 2 (FIG. 8)

Alar expanse 16 mm.

Labial palpus ocherous white; second segment shaded ochraceous buff basally on outer side; third segment brown dorsoposteriorly. Antenna grayish fuscous, basally suffused tawny; scape tawny. Head

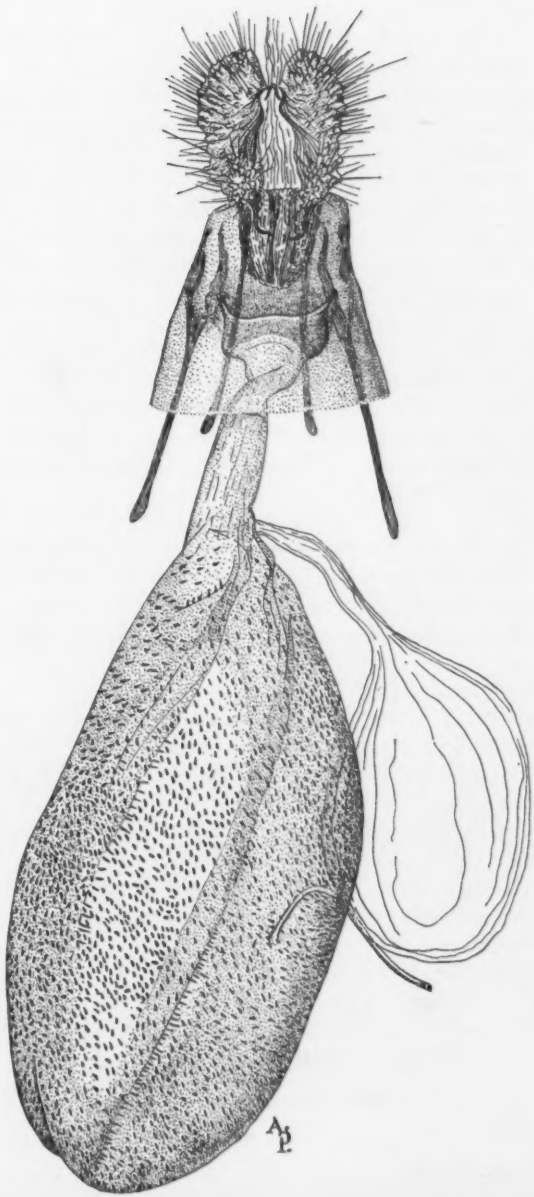


FIGURE 16.—*Amallectis frangula*, new species: ventral view of female genitalia.

ocherous white shaded ochraceous buff laterally and posteriorly. Thorax olivaceous with slight brassy hue. Forewing ground color ocherous white; extreme costal edge ochraceous tawny to two-thirds, shading to olivaceous brown for a short distance toward cell, parallel to costa; at two-thirds the olivaceous brown coloring forms a triangle, the apex of which extends nearly to end of cell; from near base to tornus a broad gray shade with tiny, short, transverse strigulae on dorsal edge and toward tornus two transverse brassy bars; apical third russet, interrupted by an oblique bar of ground color suffused pale russet, and an apical area of same color; from dorsal edge near base, an olivaceous shade extending well into cell; cilia ochraceous buff mixed with some paler scales.

Hindwing fuscous; cilia grayish fuscous. Foreleg ocherous white strongly overlaid fuscous outwardly; midleg ocherous white; tibia suffused tawny on outer side; tarsal segments fuscous on outer side; hindleg ocherous white with small, ill-defined fuscous spot on tibia, and tarsal segments with slight infuscation. Abdomen fuscous dorsally, ocherous white ventrally.

Female genitalia slide JFGC no. 11637. Ostium moderately broad, ventral edge concave. Antrum broadly sclerotized for short distance. Inception of ductus seminalis from side of bursa copulatrix. Ductus bursae membranous. Accessory bursa from near junction of bursa copulatrix and ductus bursae. Bursa copulatrix clothed with fine spines.

Holotype: U.S. National Museum No. 69733.

Type-locality: Venezuela, Aragua, Rancho Grande, 1100 m.

Distribution: Known only from the type-locality.

Described from the holotype female (16–23.X.1966, S. S. and W. D. Duckworth).

The three species *peñai*, *anaxia*, and *frangula* are closely similar and obviously closely related. Of these, *peñai* can at once be distinguished from the other two by its very pale hindwing; and *frangula* can be distinguished from *anaxia* by the extensive gray dorsal patch, absent in the latter species.

It is strange that not a single male of any of the three species has appeared although the dates of collection cover much of the year. This suggests some peculiar behavioral pattern for the males, an interesting subject for investigation.

***Amallectis anaxia*, new species**

FIGURE 17; PLATE 2 (FIG. 1)

Alar expanse 17 mm.

Labial palpus ocherous white; second segment ochraceous buff on

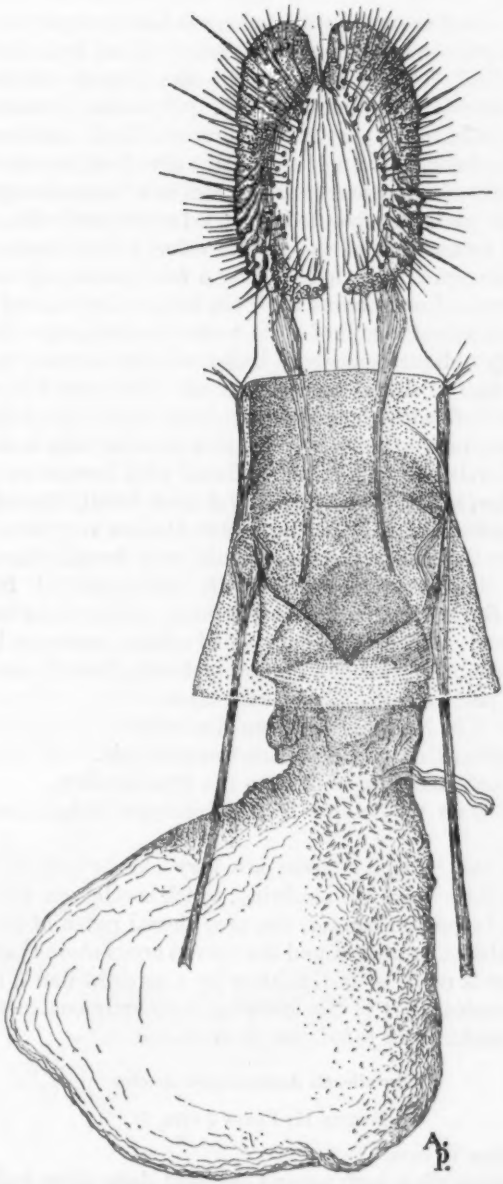


FIGURE 17.—*Amallectis anaxia*, new species: ventral view of female genitalia.

outer side; third segment with ocherous-fuscous spot on outerside. Antenna pale brown; scape ochraceous buff. Head light buff; laterally ochraceous buff. Thorax pale grayish olive; tegula ochraceous buff anteriorly. Forewing ground color pale buff; costa ochraceous buff on basal fifth followed by gray then ochraceous buff, the three areas of equal length; from inner angle a slightly curved ochraceous-buff fascia extends to end of cell, where it terminates in a few leaden-gray scales; dorsally this fascia is separated from a fuscous and ochraceous-buff blotch by a narrow line of the ground color; before tornus an ochraceous-buff triangular spot followed by a few leaden-gray scales, then a larger blotch of ochraceous buff, the latter edged along vein 5 by fuscous; from apical fourth of costa to termen, between vein 5 and 6, an outwardly oblique ochraceous-buff fascia terminating in a fuscous spot; outer half of dorsal margin marked with several short fuscous dashes; cilia buff with slightly darker basal band. Hindwing grayish fuscous, paler basally; cilia pale grayish fuscous with a darker subbasal line. Foreleg ocherous white suffused with fuscous on outer side; midleg similar; hindleg light buff; tibial spurs faintly tipped brown.

Female genitalia slide JFGC no. 11216. Ostium very broad; anterior edge deeply V-shaped. Ductus bursae very broad, short, slightly sclerotized, lightly sculptured, hardly differentiated from bursa copulatrix. Bursa copulatrix membranous, with slight sculpturing posteriorly and clothed with short, small spines; accessory bursa from juncture of ductus bursae and bursa copulatrix. Lamella antevaginalis and lamella postvaginalis lightly sclerotized.

Holotype: U.S. National Museum No. 69735.

Type-locality: Guatemala, Volcan Santa Maria.

Distribution: Recorded only from the type-locality.

Described from the unique female holotype (Schaus and Barnes. VII).

This and the foregoing *peñai* are very closely related but differ markedly in the color of the hindwing, which is ocherous white in *peñai* and grayish fuscous in *anaxia;* the gray dorsal patch of the forewing of *peñai* is absent in *anaxia* and the curved crescentic subapical fascia of the former is replaced in the latter by a straight band; the ground color of the apical part of the forewing is strongly contrasted against the darker markings in *peñai*, not so in *anaxia*.

Amallectis domna, new species

FIGURE 18; PLATE 2 (FIG. 4)

Alar expanse 15 mm.

Labial palpus olive buff; second segment deep olive buff on outer side, except apex; third segment almost wholly deep olive buff. Antenna fuscous basally shading to gray apically. Head pale olive buff, some-

what darker laterally, thorax deep olive buff suffused with fuscous; tegula pale olive buff apically. Forewing ground color very pale olive buff; basal fourth of costa, inwardly to cell, deep olive buff suffused with fuscous; from inner angle, well into cell, an oblique, narrowly triangular olive-gray shade; from basal third of dorsum to middle of cell a well-defined, outwardly oblique, blackish-fuscous fascia followed outwardly to tornus by an olive shade; from the apical corner of the dark fascia a slender blackish-fuscous line parallels dorsum to end of cell, where it broadens into an area irrorate with blackish-fuscous scales; from apical third of costa to tornus an irregular, indistinct, olive-buff fascia; apical area grayish with scattered olive-buff and fuscous scales; dorsal edge marked with a few small fuscous points; cilia composed of mixed olive-buff, gray, and fuscous scales. Hindwing ocherous white basally shading to fuscous apically; cilia very pale, whitish basally shading to grayish fuscous apically. Foreleg buff strongly overlaid with fuscous on outer side; midleg similar to foreleg; hindleg buff, tibial spurs and tarsal segments with faint infuscation.

Male genitalia slide JFGC no. 11617. Harpe moderately narrow, unornamented; cucullus rounded; sacculus dilated basally. Uncus absent. Socii large, fleshy. Vinculum not coalesced. Tegumen broad, about half the length of harpe. Anellus a broadly oval, sclerotized plate. Aedeagus stout, slightly curved, pointed; vesica armed with one large cornutus.

Holotype: U.S. National Museum No. 69736.

Type-locality: Colombia, Nariño, Volcan Galeras, 3100 m.

Distribution: Known only from the type-locality.

Described from the unique male holotype (14 Jan. 1959. J. F. G. Clarke).

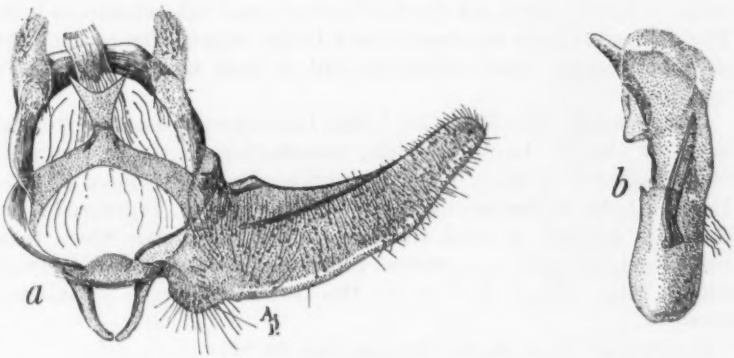


FIGURE 18.—*Amallectis domna*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

This species is very close to *A. devincta* Meyrick, from Peru, but is a slightly larger species. The prominent, fleshy socii at once set *domna* apart from *devincta*. It is further distinguished from *devincta* by the large cornutus, which is nearly half the length of the aedeagus; that of *devincta* is less than one-third the length of the aedeagus.

Phalonidia LeMarchand

Phalonidia heterophaea, new species

FIGURE 19; PLATE 4 (FIG. 1)

Alar expanse 11 mm.

Labial palpus pale buff; second segment suffused clay color with scattered brownish irrorations on outer side. Antenna grayish fuscous; scape buff, lightly suffused with fuscous. Head buff, tinged clay color laterally. Thorax buff; tegula grayish buff. Forewing ground color buff variously marked and suffused with dark olive buff; basal half of costa suffused grayish; on middle of costa a blackish-fuscous rectangular patch; two short transverse bars of the same color slightly before and at end of cell; before middle of termen two or three short, slender blackish-fuscous transverse dashes; from base of blackish-fuscous costal patch an irregular dark olive-buff transverse fascia reaching middle of dorsum; from apical fourth of costa an outwardly curved, crescentic, dark olive-buff bar ending at about vein 6; dorsum marked with scattered blackish-fuscous scales; underside strongly infuscated except outer half of costa; cilia olive buff. Hindwing shining grayish buff, darker toward margins; cell very thinly scaled; cilia grayish, darker around termen and apex. Foreleg buff, heavily overlaid with fuscous on outer side; midleg similar but less strongly marked fuscous; hindleg buff with slight grayish-fuscous suffusion on outer side. Abdomen grayish fuscous dorsally; ventrally buff except segments 5 and 6, which are grayish fuscous; anal tuft ochraceous buff. The sixth sternum is developed into a hollow evagination terminating in two divergent arms, turned upward on each side of the seventh segment.

Male genitalia slide JFGC no. 11645. Harpe broad basally narrowing abruptly slightly beyond middle, terminating in a very narrow, bluntly pointed cucullus. Transtilla with long median pointed process. Uncus tubular, enclosing anal tube. Vinculum narrow. Tegumen broad, rounded. Anellus an oval sclerotized plate. Aedeagus more than twice the length of harpe, curved and pointed distally; vesica armed with a long (almost as long as the entire aedeagus), undulating cornutus.

Holotype: U.S. National Museum No. 69749.

Type-locality: Colombia, Antioquia, La Estrella, 1730 m.

Distribution: Known only from the type-locality.

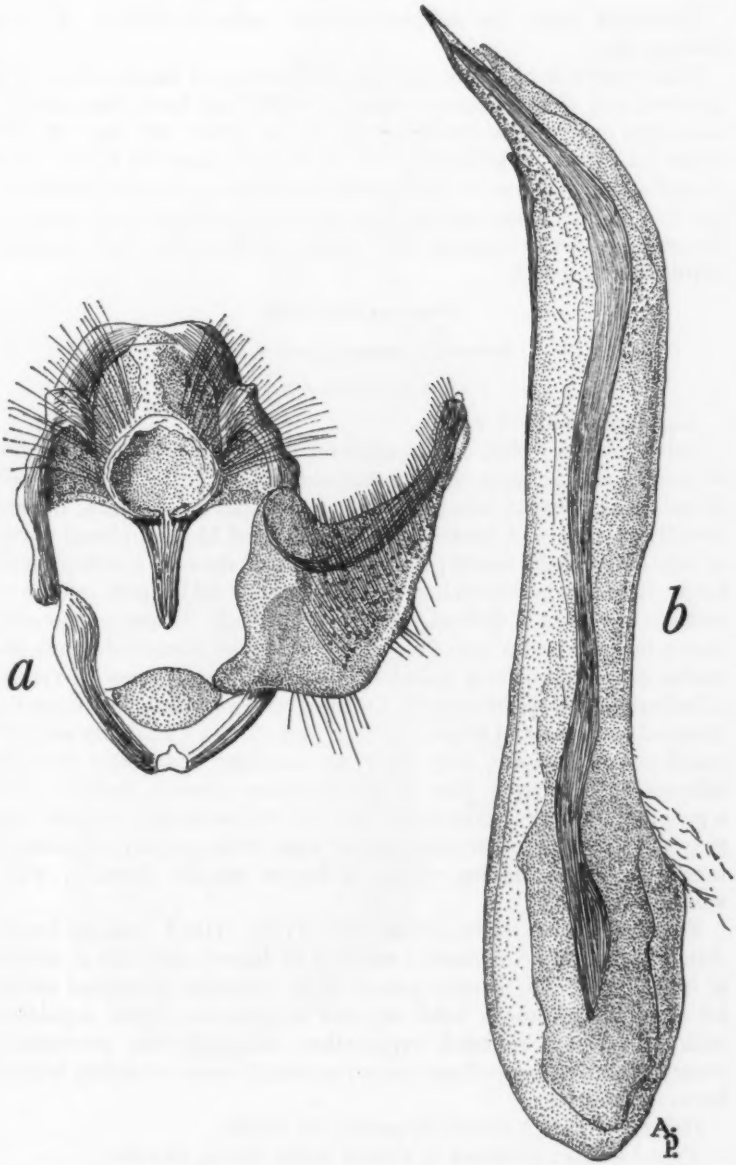


FIGURE 19.—*Phalonidia heterophaea*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

Described from the unique holotype male (13.XII.59, F. Luis Gallego M.).

This species is of particular interest because of the modified sixth sternum and the enormous cornutus, which has been demonstrated elsewhere only in the family by Razowski (1964: 367, figs. 28, 29), where he figures *P. ichthyochroa* (Walsingham) from St. Croix. Razowski's figure 28 does not correspond to other species in *Phalonidia*, nor does it match *heterophaea*. The enormous aedeagus and cornutus, however, relate *heterophaea* and *ichthyochroa*, which will probably require a new genus.

Irazona Razowski

Irazona icogramma, new species

FIGURE 20; PLATE 4 (FIG. 2)

Alar expanse 12–13 mm.

Labial palpus white; second segment tinged ocherous on outer side of basal half. Antenna grayish fuscous; scape white in distal half. Head white. Thorax fuscous. Forewing ground color white; dorsum broadly marked with leaden gray strigulae and blotches; basal patch, except dorsal half, tawny; at outer third of dorsum a conspicuous, large, fuscous spot reaching slightly beyond fold; from middle of costa to tornus an ill-defined, irregular, outwardly oblique, ochraceous-tawny fascia preceded and followed by scattered blackish-fuscous and leaden-gray scales; from apical third of costa, to termen at vein 5, a leaden-gray fascia with spots of ochraceous-tawny and fuscous scales along edges; apex and a spot between veins 2 and 4 similarly colored; costal scales elongate, clay color, at one-third; underside strongly infuscated; cilia light clay color. Hindwing grayish fuscous; cilia a pale grayish with darker subbasal line. Foreleg white, overlaid with grayish fuscous on outer side; midleg white with grayish suffusion on tarsal segments; hindleg white. Abdomen grayish dorsally, white ventrally.

Female genitalia slides JFGC nos. 11221, 11642. Ostium broad. Antrum strongly sclerotized. Inception of ductus seminalis at middle of bursa copulatrix. Ductus bursae short, strongly sclerotized except for small membranous band anterior to antrum. Bursa copulatrix with sclerotized, rounded evagination on right side posteriorly; inner wall clothed with sharp spines; accessory bursa extending beyond bursa copulatrix.

Holotype: U.S. National Museum No. 69750.

Type-locality: Guatemala, Volcan Santa Maria, October.

Distribution: Guatemala.

Described from the female holotype (October) and one ♀ paratype

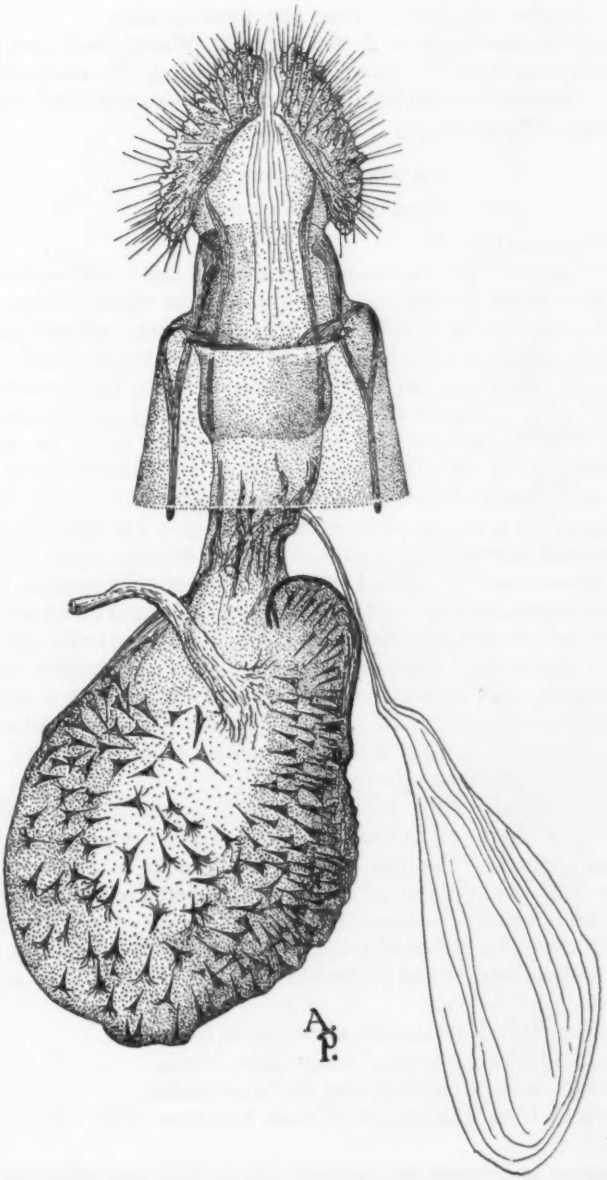


FIGURE 20.—*Irazona icogramma*, new species: ventral view of female genitalia.

(July), Schaus and Barnes, from the same locality.

Similar in appearance to *Irazona cognata* (Walsingham) but generally darker and with a much darker hindwing. No comparison of the genitalia can be made because *cognata* is represented by a male and *icogramma* is known only from females.

Irazona turbula, new species

FIGURE 21; PLATE 4 (FIG. 3)

Alar expanse 16 mm.

Labial palpus white; second segment with slight buff suffusion on outer side. Antenna grayish fuscous with some white scaling dorsobasally; scape white. Head white. Thorax white, suffused grayish. Forewing ground color white; dorsum broadly marked with wood-brown and gray bars, all confluent; basal patch, from one-fifth of costa to dorsum, grayish fuscous; on costa, slightly beyond middle, a pale grayish blotch with two small, darker gray spots on extreme costal edge; at end of cell a short, irregular, longitudinal grayish dash with a small spot of fuscous scales at outer end; from costa, slightly before apex, to vein 6 an outwardly oblique gray bar narrowly edged with grayish-fuscous and yellowish scales; extreme apex narrowly gray; between end of cell and subapical bar several irregular, faintly gray transverse strigulae; costal scales elongate beyond basal patch and also beyond middle; underside moderately infuscated; cilia pale gray at apex, white around termen and tornus. Hindwing grayish fuscous, paler basally; cilia sordid white to pale gray with darker subbasal line. Foreleg ocherous white suffused grayish fuscous on outer side; midleg similar to foreleg; hindleg ocherous white. Abdomen gray; first to third segments paler ventrally.

Female genitalia slide JFGC no. 11641. Ostium broad, slitlike. Antrum not developed. Ductus seminalis from center of right side of bursa copulatrix. Ductus bursae membranous in posterior half; anterior half ornamented with very fine sclerotized ridges. Bursa copulatrix irregularly ornamented with very fine sclerotized ridges and with a small sclerotized evagination posteriorly; accessory bursa not extending beyond end of bursa copulatrix; lamella antevaginalis crescentic.

Holotype: U.S. National Museum No. 69751.

Type-locality: Guatemala, Volcan Santa Maria.

Distribution: Known only from the type-locality.

Described from the unique female holotype (July, Schaus and Barnes).

Similar to *icogramma* but without the conspicuous subtornal spot and with a short subapical, transverse fascia. The female genitalia are similar, and the close relationship is indicated by the sclerotized

FIGURE 21.—*Irazona turbula*, new species: ventral view of female genitalia.

evagination from the posterior side of the bursa copulatrix. The ornamentation of the inner wall of the bursa copulatrix differs, being composed of fine spines in *icogramma* and fine ridges in *turbula*.

***Irazona ademonia*, new species**

FIGURE 22; PLATE 4 (FIG. 4)

Alar expanse 16 mm.

Labial palpus white; second segment tinged ochraceous buff on outer side; third segment gray apically. Antenna grayish fuscous; scape grayish buff basally, white apically. Head white with some grayish scales posterolaterally. Thorax grayish fuscous, paler posteriorly; tegula pale grayish posteriorly. Forewing ground color white; dorsum broadly marked leaden gray and white mixed; basal patch, from basal fifth of costa to dorsum, grayish-fuscous; on dorsum, before tornus, a ring of fuscous scales surrounding a leaden-gray area; on costa, at middle, a pale leaden-gray spot edged posteriorly and anteriorly with buff; between dorsal and costal spots several pale gray spots and short dashes mixed with buff; subapically, from costa to vein 4, a curved, pale leaden-gray transverse fascia edged with buff; apex narrowly grayish fuscous; costal scales elongate beyond basal patch and beyond midcostal spot; underside moderately infuscated; cilia mixed gray and white. Hindwing grayish fuscous; cilia very pale gray with darker subbasal line. Foreleg ocherous white, suffused fuscous on outer side; midleg ocherous white with slight fuscous suffusion on outer side of tibia; hindleg ocherous white. Abdomen gray; ventrally first three segments paler.

Female genitalia slide JFGC no. 11640. Ostium very broad; anterior edge concave. Antrum broadly sclerotized. Inception of ductus seminalis from center of bursa copulatrix ventrally. Ductus bursae lightly sclerotized except for narrow membranous area anterior to antrum. Bursa copulatrix ornamented with fine spines and with a strongly sclerotized bulge dorsoanteriorly on right side. Accessory bursa not extending beyond anterior end of bursa copulatrix.

Holotype: U.S. National Museum No. 69752.

Type-locality: Costa Rica, La Florida, 500 feet.

Distribution: Known only from the type-locality.

Described from the female holotype (William Schaus).

This species is very near *turbula* but the latter lacks the subtornal dorsal ring, and the subapical fascia is much longer in *ademonia* than in *turbula;* the forewing of *ademonia* is broader than that of *turbula*.

Further differences may be seen in the genitalia, particularly in the position of the sclerotized swelling, or evagination, from the bursa copulatrix. The characters of the ductus bursae are widely different, also, as may be seen by a comparison of the figures.

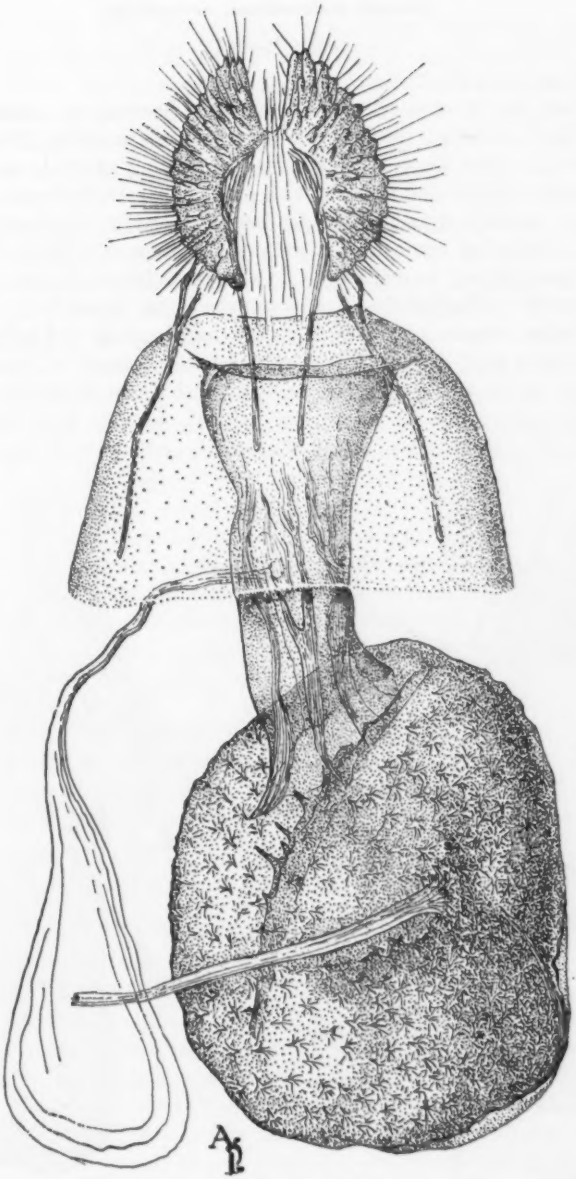


FIGURE 22.—*Irazona ademonia*, new species: ventral view of female genitalia.

Irazona melanoleuca, new species

FIGURE 23; PLATE 1 (FIG. 8)

Alar expanse 21–22 mm.

Labial palpus white; second segment fuscous on outer side of basal half. Antenna fuscous; basal half of scape white. Head white. Thorax fuscous; tip of tegula white. Forewing ground color white, variously suffused and marked with gray; basal sixth of costa blackish fuscous continuing across fold, forming a dark, triangular basal patch containing some leaden gray scaling; from middle of costa a broad gray blotch to cell where, in some specimens, it becomes confluent with a blackish-fuscous band, the latter extending to dorsum well before tornus; on costa, between basal patch and gray blotch, 3 or 4 short gray dashes; from outer fourth of costa to vein 5 a rectangular patch of mixed gray and blackish fuscous continued from its outer extremity as a narrow, curved, fuscous line, to tornus; apical area beyond the rectangular patch spotted with fuscous and

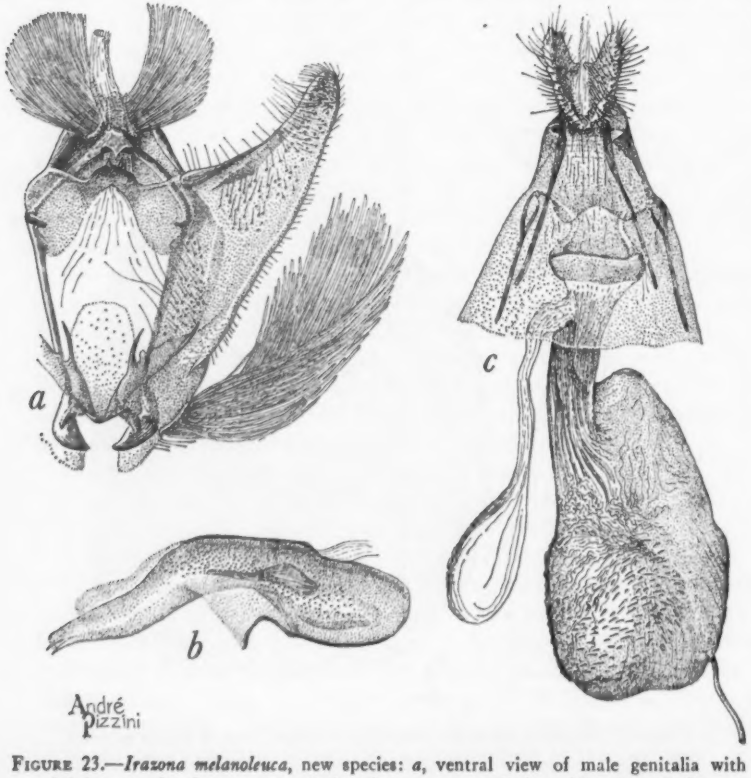


FIGURE 23.—*Irazona melanoleuca*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

gray; cilia white with broad gray basal band. Hindwing grayish fuscous, paler basally; cilia gray with darker basal band. Foreleg white on inner side, fuscous outwardly; tarsal segments narrowly banded white; midleg white, suffused with fuscous on outer side of femur and tibia; tarsus with spots of fuscous; hindleg ocherous white, faintly marked with grayish. Abdomen white, suffused grayish dorsally and ventrally.

Male genitalia slide JFGC no. 11211. Harpe triangular, very broad basally; cucullus bluntly pointed; sacculus with a sharp, curved spine near base on inner side and a conspicuous hairpencil on outer side. Uncus a very short, digitate process. Transtilla widely expanded laterally; median area narrowed and armed with a few sharp teeth. Vinculum not coalesced at middle; lateral elements curved and thickened anteriorly. Tegumen short and broad. Anellus an elongate, sclerotized plate. Aedeagus stout basally, curved, terminating in a point; vesica armed with a single slender cornutus, dilated basally.

Female genitalia slides JFGC nos. 11624, 11212. Ostium broad, slitlike, posteroventral edge slightly convex. Inception of ductus seminalis dorsally from about middle of bursa copulatrix. Ductus bursae broad, short, ornamented with sclerotized ribs that extend into bursa copulatrix posteriorly; signum absent. Accessory bursa not reaching beyond anterior end of bursa copulatrix.

Holotype: U.S. National Museum No. 69732.

Type-locality: Mexico, Pue.

Distribution: Mexico.

Food plant: *Pinus* species.

Described from the male holotype and 2 ♀♀ paratypes all with identical data (January 1960. Guevara. Rf. *Pinus*).

There appears to be no known close relative of this species except the following, newly described *platina*.

Irasona platina, new species

FIGURE 24; PLATE 2 (FIG. 5)

Alar expanse 16 mm.

Labial palpus fuscous; third segment white on inner side. Antenna fuscous; scape white. Head white. Thorax fuscous with some white posteriorly. Forewing ground color silvery white with pale greenish-yellow reflections; basal fifth of costa, to fold, fuscous; on midcosta a broad, truncated triangular mark extends across end of cell; on costa, between midcostal mark and apex, two grayish-fuscous spots; on dorsum before tornus an elongate, transverse triangular spot preceded and followed by small fuscous dashes; from apex, along termen, a broad fuscous band interrupted by white spots; underside of forewing fuscous; cilia mixed ochraceous buff and fuscous. Hind-

wing sordid white with a fuscous shade around termen and mottled with fuscous inwardly. Foreleg fuscous; tarsal segments narrowly banded with white; midleg similar to foreleg; hindleg ocherous white faintly irrorate with fuscous. Abdomen removed before description.

Male genitalia slide 63–Obr., 1963. Harpe triangular, very broad basally; cucullus narrow, bluntly pointed. Socii two broad, fleshy lobes. Uncus a short, digitate process. Transtilla very broadly expanded laterally, constricted before middle, then expanded; median section armed with many sharp teeth. Vinculum not coalesced. Tegumen about as long as harpe. Anellus a deeply concave plate, fused with base of harpe by a long sclerotized rod, the latter dentate along most of its length. Aedeagus stout, curved, terminating in a pair of sharp points; vesica armed with one large and numerous spiculate cornuti.

Holotype: U.S. National Museum No. 69738.

Type-locality: Costa Rica, Mount Poas.

Distribution: Costa Rica.

Described from the unique male holotype (May).

In appearance similar to *melanoleuca*, but the dark basal patch does not extend across the wing as in that species, and there are pale yellow-green reflections, absent in *melanoleuca*. The genitalia of *platina* lack the strong hairpencil that is present in *melanoleuca*, and the median area of the transtilla is much broader and armed with many spines. The fused anellus and harpe are a distinguishing character of *platina*.

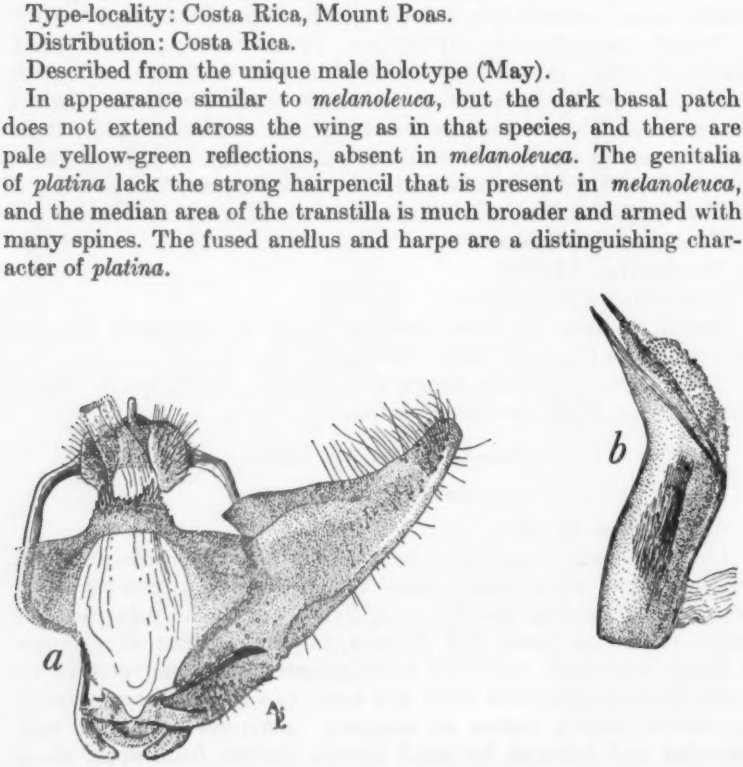


FIGURE 24.—*Irazona platina*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus.

Lasiothyris Meyrick

Lasiothyris dysmorphia, new species

FIGURE 25; PLATE 2 (FIG. 6)

Alar expanse 14 mm.

Labial palpus pale buff with fuscous irroration on outer side. Antenna grayish, finely spotted with fuscous basally; scape pale buff with fuscous irroration dorsally. Head pale brown, mixed with buff laterally; face buff. Thorax buff, mixed with pale brown and fuscous; tegula brown, narrowly edged with buff. Forewing ground color pale buff, irregularly irrorate with fuscous and spotted with pale brown; from basal fifth of costa almost to inner angle an ill-defined, brown, basal patch; from slightly beyond middle of costa to dorsum a poorly defined, irregular, brown, transverse fascia that extends narrowly along dorsum to basal third; at apical fifth of costa a quadrate brown blotch; apical area mottled brown; underside strongly infuscated; cilia mixed buff, brown, and fuscous. Hindwing pale buff, slightly shaded fuscous and with fuscous irroration around anal angle; costal hairpencil of male with black spot near outer end. Foreleg buff; femur and tibia fuscous on outer side; tarsal segments broadly banded with fuscous; midleg similar to foreleg; hindleg buff; femur with slight fuscous marking basally on outer side; tibia with sparse fuscous scaling at bases of spurs. Abdomen grayish with some heavy fuscous scaling dorsally; ventrally ocherous white, irrorate with grayish fuscous; anal tuft ocherous white.

Male genitalia slides JFGC nos. 11233, 11628. Harpe very broad basally, abruptly narrowed toward cucullus; cucullus expanded into two widely separated parts; sacculus produced into a long, curved point, the latter preceded by a dense patch of long, stiff setae and a sharp longitudinal ridge. Uncus absent or only faintly indicated. Socii fused along median line, flattened, and with a circular terminal excavation. Vinculum coalesced, broad. Transtilla arched and with double-keeled, median process fused distally. Tegumen very short, arched. Anellus a U-shaped, sclerotized plate. Aedeagus long, slender, curved, terminating in a blunt point; vesica armed with a single, short cornutus.

Holotype: U.S. National Museum No. 69739.

Type-locality: Bolivia, Cochabamba, Incachaca. Tropical cloud area, 2100 m.

Distribution: Known only from the type-locality.

Described from the male holotype (27.VIII–5.IX.56. L. Peña), and one ♂ paratype with the same data.

The extraordinary male genitalia immediately distinguish *dysmorphia* from any of the related species. It appears to be more closely

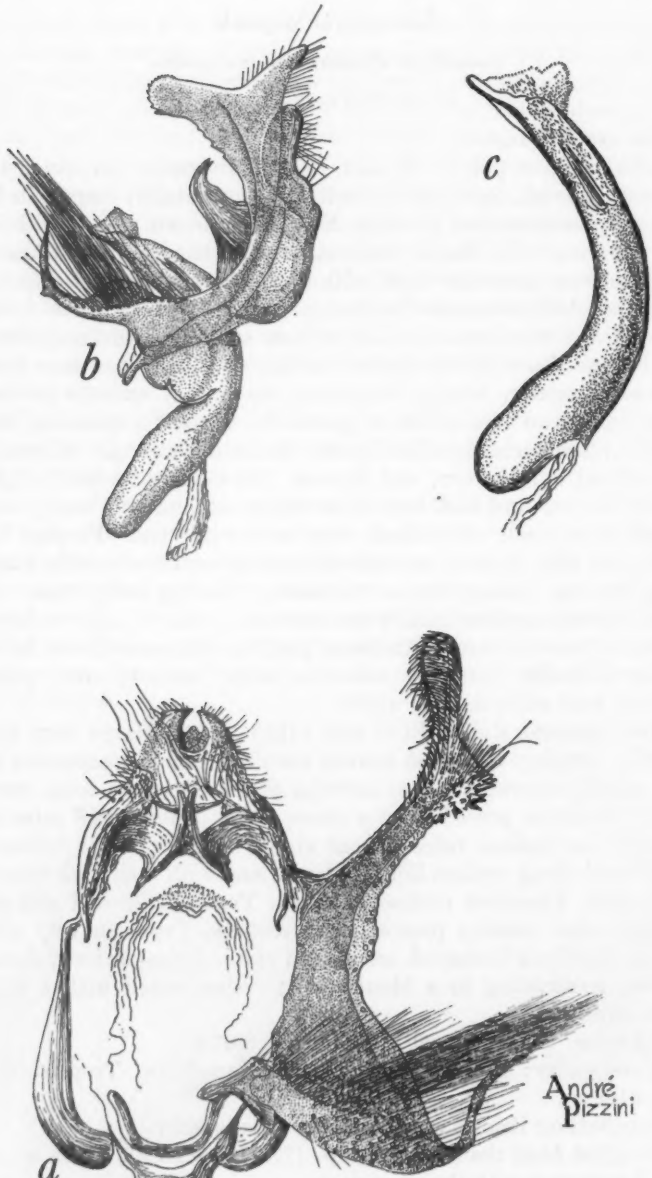
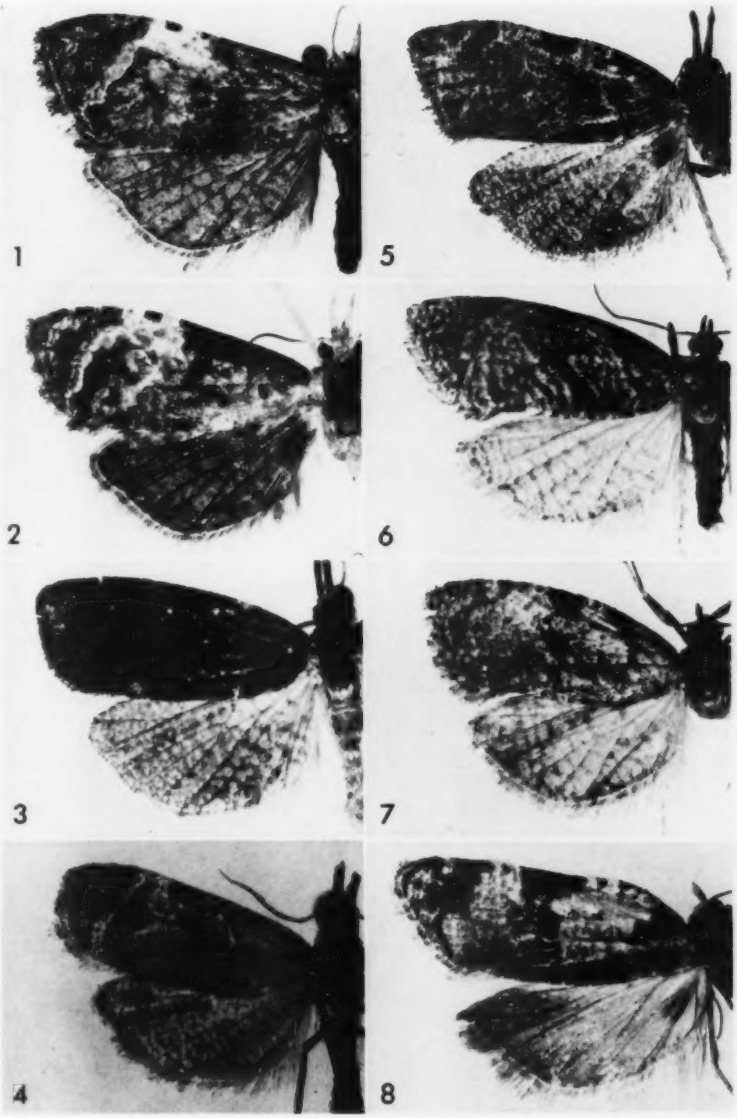
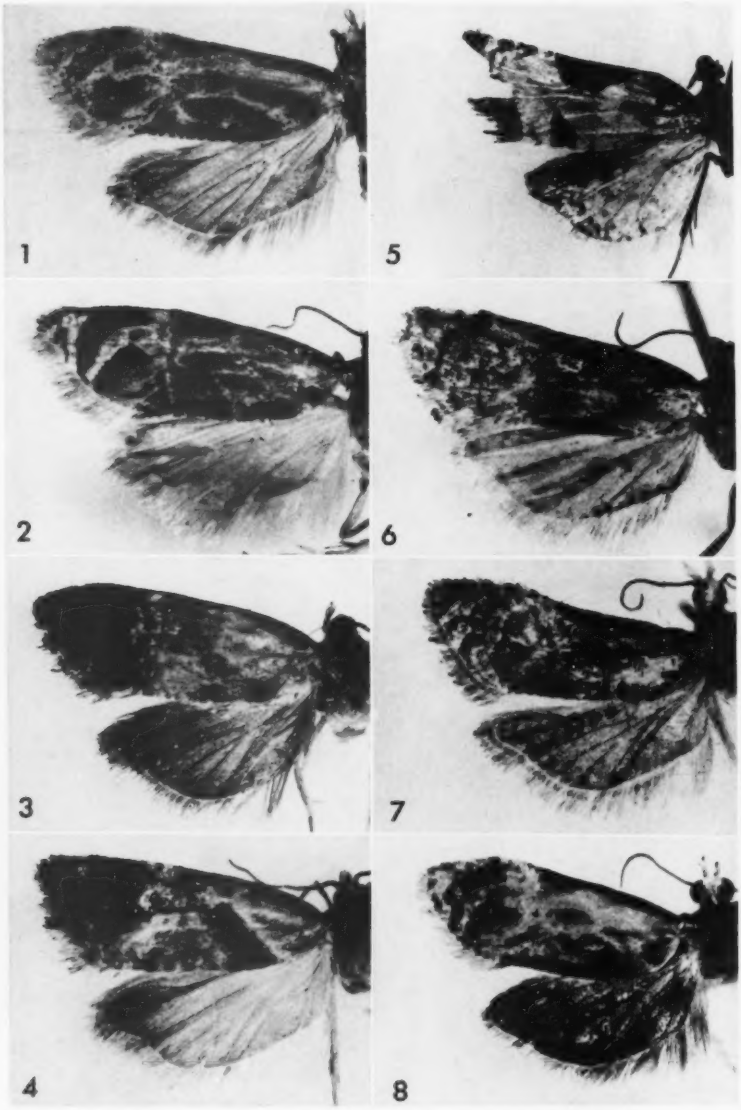


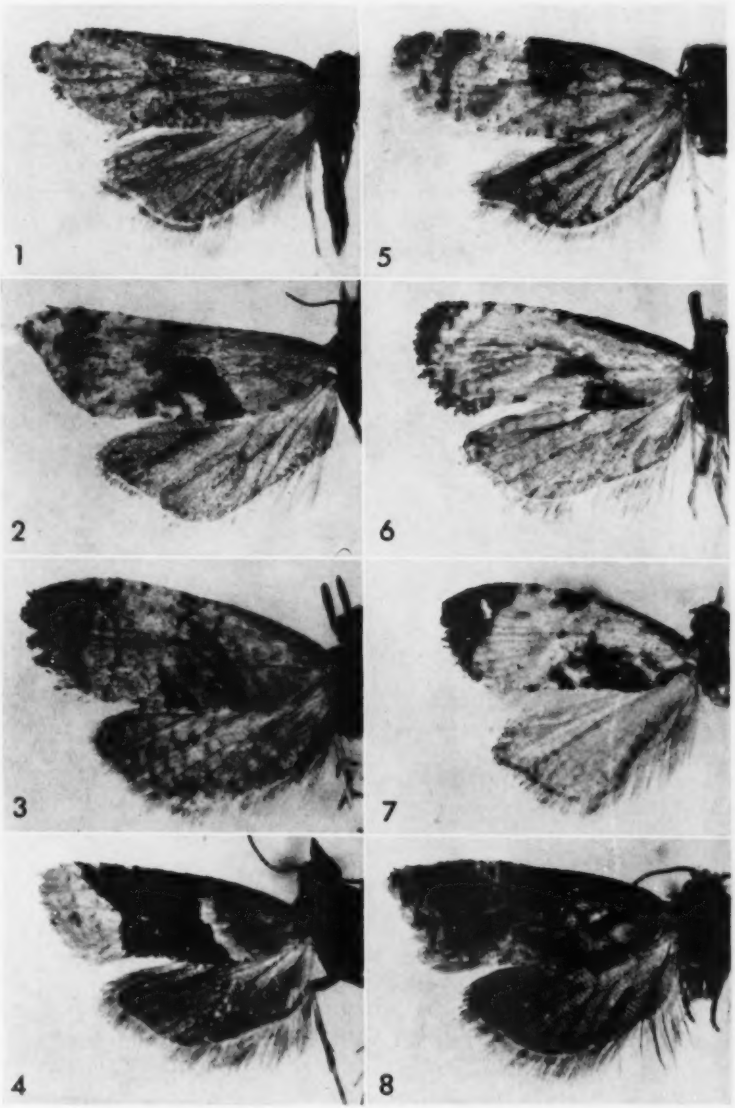
FIGURE 25.—*Lasiothyris dysmorphia*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, lateral aspect of male genitalia with aedeagus in situ; *c*, aedeagus.



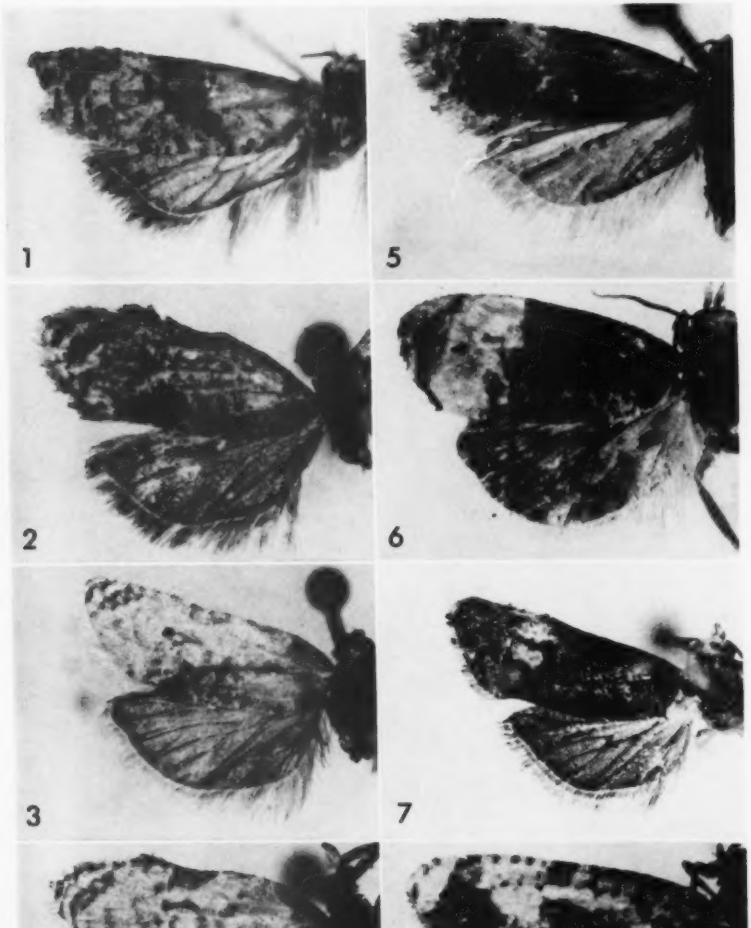
FIGURES 1–8.—1, *Hysterosia turialba* Busck, Guatemala, Volcan Santa Maria; 2, *Hysterosia alphitopa*, new species (paratype), Venezuela, Aragua, Rancho Grande; 3, *Hysterosia iodes*, new species (holotype), Guatemala, Volcan Santa Maria; 4, *Hysterosia melasma*, new species (paratype), Guatemala, Chejel; 5, *Hysterosia gigantica* Busck (type), Mexico, Mexico City; 6, *Phalonia embrithopa* Meyrick, Colombia, Cauca, Páramo de Puracé, Lake San Rafael; 7, *Phalonia embrithopa* Meyrick, Colombia, Nariño, Volcan Galeras; 8, *Irazona melanoleuca*, new species (paratype), Mexico, Pue.



FIGURES 1–8.—1, *Amallectis anaxia*, new species (holotype), Guatemala, Volcan Santa Maria; 2, *Amallectis peñai*, new species (holotype), Bolivia, Cochabamba, Incachaca; 3, *Amallectis nephelodes*, new species (holotype), Bolivia, Cochabamba, Incachaca; 4, *Amallectis domna*, new species (holotype), Colombia, Nariño, Volcan Galeras; 5, *Irazona platina*, new species (holotype), Costa Rica, Mount Poas; 6, *Lasiothyris dysmorphia*, new species (paratype), Bolivia, Cochabamba, Incachaca; 7, *Phalonia tornosema*, new species (paratype), Guatemala, Volcan Santa Maria; 8, *Amallectis frangula*, new species (holotype), Brazil, Nova Teutonia.



FIGURES 1–8.—1, *Lasiothyris hemitephras*, new species (holotype), Mexico, Tehuacan; 2, *Cochylis mendora*, new species (paratype), Chile, Santiago Prov., Cajon de Maypo, Cordillera, El Canelo; 3, *Cochylis laetitia*, new species (holotype), Argentina, Tucumán, Ciudad Universitaria; 4, *Cochylis caesiata*, new species (holotype), Venezuela, Aragua, Rancho Grande; 5, *Phtheochroa arrhostia*, new species (holotype), Peru, Cusco, Machu Picchu; 6, *Carolella asthenia*, new species (holotype), Guatemala, Palin; 7, *Phalonia charma*, new species (holotype), Argentina, Tucumán, Ciudad Universitaria; 8, *Carolella molybdina*, new species (paratype), Mexico, S.L.P., Tamazunchale.



FIGURES 1–8.—1, *Phalonidia heterophaea*, new species (holotype), Colombia, Antioquia, La Estrella; 2, *Irazona icogramma*, new species (holotype), Guatemala, Volcan Santa Maria; 3, *Irazona turbula*, new species (holotype), Guatemala, Volcan Santa Maria; 4, *Irazona ademonia*, new species (holotype), Costa Rica, La Florida; 5, *Lasiothyris diamphidia*, new species (paratype), Peru, Cusco, Machu Picchu; 6, *Cochylis serena*, new species (paratype), Brazil, Nova Teutonia; 7, *Phalonia vesta*, new species (holotype), Venezuela, Aragua, Rancho Grande; 8, *Cochylis constantia*, new species (holotype), Peru, Cusco, Machu Picchu.

related to *diamphidia* than any of the others but is easily separated by the genitalia.

***Lasiothyris diamphidia*, new species**

FIGURE 26; PLATE 4 (FIG. 5)

Alar expanse 12–14 mm.

Labial palpus ocherous white; second segment shaded with buff and irrorate with brown on outer side; apex of third segment fuscous. Antenna grayish, speckled fuscous dorsobasally; scape ocherous white with fine fuscous irrorations. Head ocherous white, mixed with pale brown laterally and on crown. Thorax light brown, slightly suffused fuscous; tegula ocherous white posteriorly. Forewing ground color ocherous white suffused with buff; basal fifth light clay color, forming an ill-defined basal patch; costa finely strigulated with fuscous; from middle of costa to dorsum an inwardly oblique, clay color, transverse fascia, wider on dorsum than on costa and mixed with blackish-fuscous scales on dorsum and on dorsal half of inner margin; on tornus a large, tawny blotch, irrorate with blackish fuscous; from apical fourth of costa a tawny fascia outwardly oblique and attenuated to vein 4; subapically, on costa, a tawny spot; apical portion of wing with ill-defined, light clay color, transverse dashes and scattered blackish-fuscous scales; underside strongly infuscated except on apical half of costa; cilia buff mixed with gray-tipped scales. Hindwing ocherous white with grayish-fuscous shading at anal angle and on inner margin; apex with some short grayish-fuscous strigulae; cilia light buff with grayish subbasal line. Foreleg ocherous white; femur and tibia heavily irrorate with grayish fuscous on outer side; tarsal segments almost wholly overlaid fuscous; midleg similar to foreleg but tarsus less strongly marked; hindleg ocherous white; femur lightly irrorate with grayish fuscous on outer side. Abdomen grayish fuscous dorsally; buff, with fuscous irroration ventrally.

Male genitalia slide JFGC no. 11657. Harpe on right side broad, tapered to a rounded cucullus; sacculus strongly sclerotized, produced outwardly and clothed with stout, long setae; sclerotization of sacculus extended to middle of harpe into two thickened lumps. Left harpe moderately broad basally, abruptly narrowed into a slender terminal portion; from base of sacculus a long, hooked process. Uncus minutely developed and fused with bases of socii. Socii fused along median line, except at distal end. Vinculum coalesced and intimately associated with anellus. Tegumen nearly as long as harpe. Anellus a long U-shaped plate fused with aedeagus. Aedeagus long, rather slender open S-shaped, terminating in a sharp point; vesica unarmed.

Female genitalia slide JFGC no. 11658. Ostium asymmetrical;

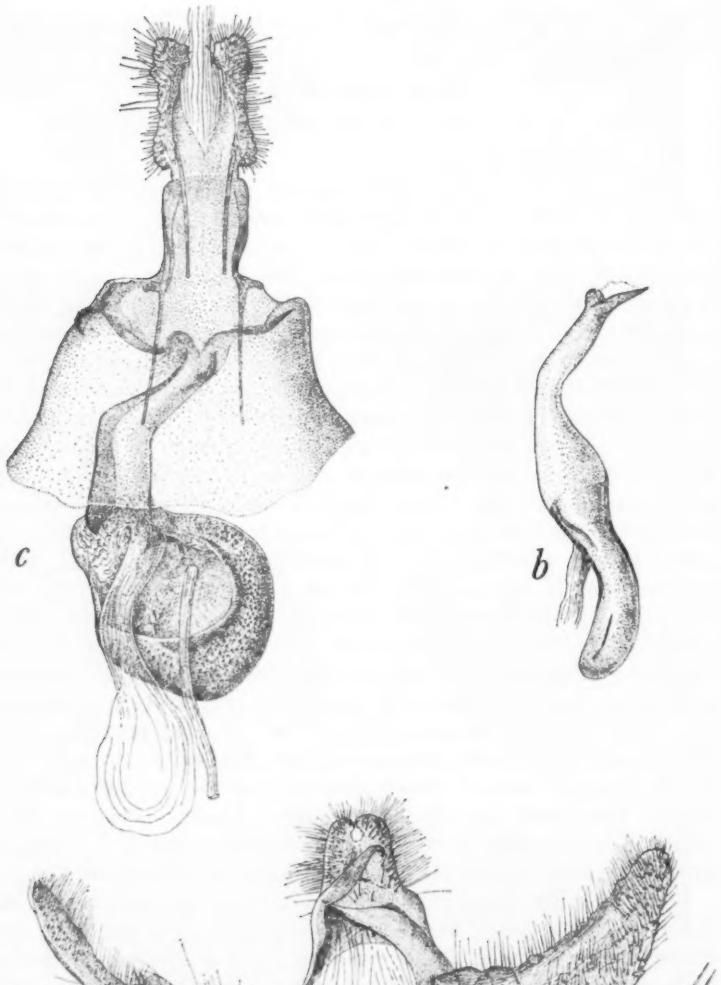


FIGURE 26.—*Lasiothyris diamphidia*, new species: *a*, ventral view of male genitalia with aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

anterior edge V-shaped, solidly fused with posterior margin of seventh sternum. Antrum not differentiated. Inception of ductus seminalis from middle of bursa copulatrix. Ductus bursae bent, sclerotized for its entire length. Accessory bursa arising at juncture of ductus bursae and bursa copulatrix. Bursa copulatrix heavily sculptured from juncture with ductus bursae to beyond middle; anteriorly and laterally clothed with a mass of short, stout spines.

Holotype: U.S. National Museum No. 69753.

Type-locality: Peru, Cusco, Machu Picchu.

Distribution: Known only from the type-locality.

Described from the male holotype (5.II.1959, J. F. G. Clarke), and 2 ♀♀ paratypes all from the same locality. The females are dated "6.II.1959."

This species is superficially very similar to *Phalonia sublimis* Meyrick but differs widely in the genitalia. The female genitalia of *diamphidia* are solidly fused with the posterior margin of the seventh sternum, those of *sublimis* are not; moreover, the ostium of *diamphidia* is markedly asymmetrical, that of *sublimis* is not. The male of *sublimis* is not known, but the male genitalia of *diamphidia* are unusually asymmetrical and the long aedeagus is fused to the anellus. I know of no other phaloniid with such marked asymmetry in the male genitalia.

***Lasiothyris hemitephras*, new species**

FIGURE 27; PLATE 3 (FIG. 1)

Alar expanse 16–18 mm.

Labial palpus ocherous white; second segment sparsely and minutely irrorate with fuscous. Antenna pale grayish fuscous; scape ocherous white. Head ocherous white; laterally and on crown, light buff. Thorax ocherous white; tegula buff anteriorly. Forewing ground color cinereous; from mid-dorsum to costal edge of cell, a transverse ochraceous-buff shade; apical third ochraceous buff, irregularly and sparsely spotted with cinereous; underside rather strongly infuscated; cilia cinereous with a dark gray basal line. Hindwing light grayish fuscous; cilia ocherous white with a gray subbasal line. Foreleg ocherous white marked with cinereous; midleg similar to foreleg; hindleg ocherous white. Abdomen pale grayish fuscous dorsally, ocherous white ventrally.

Female genitalia slides JFGC no. 11222, 11717. Ostium wide, asymmetrical. Antrum not differentiated. Inception of ductus seminalis from left side of bursa copulatrix. Ductus bursae short, very broad, strongly sclerotized, with two longitudinal, folded ridges ventrally. Bursa copulatrix mostly membranous; accessory bursa

FIGURE 27.—*Lasiothyris hemitephras*, new species: ventral view of female genitalia.

very small, from dorsal, median surface of ductus bursae.

Holotype: U.S. National Museum No. 69741.

Type-locality: Mexico, Tehuacan.

Distribution: Mexico.

Described from the female holotype (October 10) and three ♀♀ paratypes all from the same locality (September 12).

I have placed *hemitephras* in *Lasiothyris* on the basis of the asymmetrical and much involved genitalia. Males are not known but probably, when discovered, will approach *diamphidia* in the form of the genitalia.

There are no species that are similar to *hemitephras* in coloring or maculation. Superficially, the forewing of *hemitephras* appears pale gray in the basal three-fifths and ochraceous buff in the apical two-fifths.

Carolella Busck

Carolella molybdina, new species

FIGURE 28; PLATE 3 (FIG. 8)

Alar expanse 11–14 mm.

Labial palpus creamy white; second segment with slight infuscation basally on outer side. Antenna gray; scape creamy white. Head creamy white with ocherous suffusion laterally. Thorax ochraceous buff with dull fuscous suffusion; tegula paler posteriorly. Forewing ground color yellow ocher; on vein 1b three small spots of leaden gray scales, and between the basal two, touching cell, a fuscous spot; costa mostly leaden gray with short, transverse fasciae of this color at one-sixth, one-third, midcosta, and at apical third, the last continued outwardly and obliquely as a line to vein 4, then inwardly, obliquely, to tornus; several groups of leaden-gray scales between this fascia and apex; outer third of wing, between the lead-colored lines and spots, fuscous, mixed with tawny; on middle of costa a fuscous patch edged inwardly with tawny; underside fuscous, with a few whitish spots on outer half of costa; cilia alternating groups of buff and leaden-gray scales. Hindwing fuscous; paler basally; cilia light gray with a broad grayish-fuscous subbasal line. Foreleg creamy white; femur and tibia heavily overlaid with fuscous on outer side; tarsal segments broadly banded with fuscous; midleg similar to foreleg; hindleg ocherous white; tibia suffused fuscous dorsally; tarsus broadly banded with fuscous. Abdomen grayish fuscous; ventrally segments edged with ocherous white posteriorly.

Male genitalia slide JFGC no. 9624. Harpe broad, rectangular, almost as wide as long; cucullus truncate; sacculus dilated basally.

Transtilla narrow with long median projection. Uncus short, broad. Vinculum U-shaped, coalesced. Tegumen short, narrow. Anellus a U-shaped plate. Aedeagus long, slender, curved, pointed; vesica armed with a single long, slender cornutus.

Female genitalia slides JFGC nos. 11636, 11682. Ostium very wide; anterior margin concave. Antrum constricted but not differentiated from ductus bursae. Inception of ductus seminalis at juncture of ductus bursae and bursa copulatrix. Ductus bursae sclerotized; on each side a longitudinal fold. Bursa copulatrix mostly membranous with fine sculpturing and ventrally, a large, sclerotized fold. Accessory bursae arising in a depression on the left side of bursa copulatrix.

Holotype: U.S. National Museum No. 69746.

Type-locality: Mexico, S. L. P., Tamazunchale.

Distribution: Mexico.

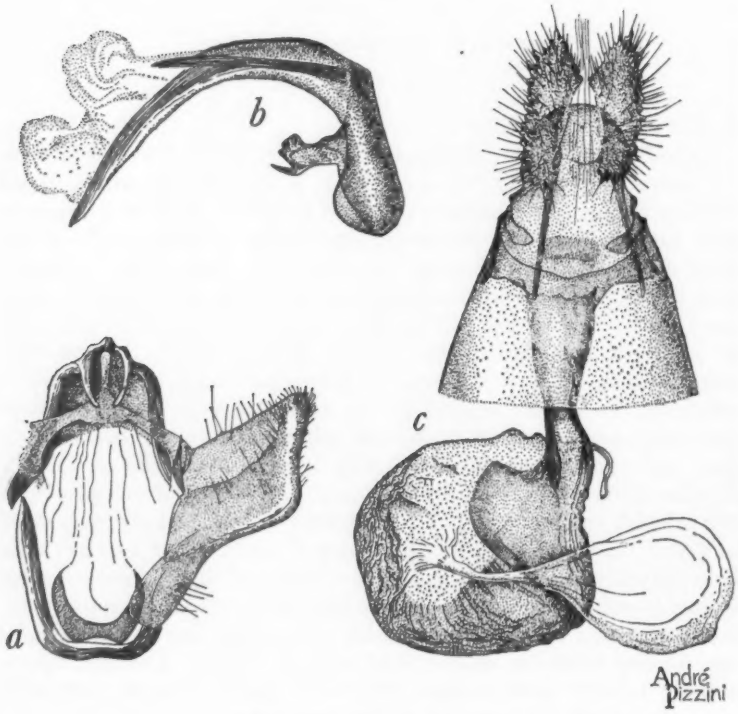


FIGURE 28.—*Carolella molybdina*, new species: *a*, ventral view of male genitalia with left harpe and aedeagus removed; *b*, aedeagus; *c*, ventral view of female genitalia.

Described from the female holotype (6 Jan. 1948, Leary), 2♀♀ and one ♂ paratypes; ♂, same locality as holotype (1.IV.47, Chapman); ♀, "Mexico" (5.IV.54, Baker and Allen); ♀, San Luis Potosi (23.IV.47, Chapman).

Food plant: "Orchid plants."

***Carolella asthenia*, new species**

FIGURE 29; PLATE 3 (FIG. 6)

Alar expanse 12 mm.

Labial palpus shining white on inner side, ocherous white on outer side. Antenna pale brown; scape white. Head white. Thorax white; tegula pale gray anteriorly. Forewing ground color creamy white; basal half of costa grayish fuscous edged with clay color on inner margin; in apical third of costa three small grayish-fuscous spots; on basal third of dorsum a fuscous blotch confluent with a clay-colored, outwardly oblique blotch that extends into middle of cell; at the end of a small fuscous dot; apical third lightly strigulated with pale ochraceous buff; extreme apex grayish fuscous; underside suffused fuscous; cilia gray, irrorate with fuscous. Hindwing very pale grayish fuscous; cilia light gray with slightly darker basal band. Foreleg ocherous with light fuscous suffusion on outer side of femur and tibia; midleg similar to foreleg; tarsus fuscous annulated; hindleg ocherous white.

Male genitalia slide JFGC no. 11616. Harpe broad basally, unornamented; cucullus rounded. Transtilla lightly sclerotized laterally with a long bluntly pointed median process. Socii long, slender, digitate,

FIGURE 29.—*Carolella asthenia*, new species: *a*, ventral view of male genitalia with aedeagus removed; *b*, aedeagus.

terminating in a point. Vinculum weak, not coalesced. Tegumen broad; truncate posteriorly. Anellus an elongate, lightly sclerotized, curved plate. Aedeagus stout, abruptly curved at distal third, sharply pointed; vesica armed with a single cornutus about half the length of aedeagus.

Holotype: U.S. National Museum No. 69747.

Type-locality: Guatemala, Palin.

Distribution: Known only from the type-locality.

Described from the unique male holotype. (July. Schaus and Barnes).

On the basis of the male genitalia I am placing this species in *Carolella*, but on habitus it is far removed from the North American members of the genus. In *asthenia* the apex of the median projection of the transtilla is spinous but in the type of the genus, *Pharmacis sartana* Hubner, it is smooth. The aedeagus of *asthenia* is less stocky than that of *sartana* and the cornutus is more slender.

Phtheochroa Stephens

Phtheochroa arrhostia, new species

FIGURE 30; PLATE 3 (FIG. 5)

Alar expanse 10–11 mm.

Labial palpus white; second segment light ochraceous buff, irrorate with fuscous on outer side. Antenna light grayish fuscous, whitish dorsobasally; scape creamy white. Head creamy white; posteriorly and laterally ocherous white. Thorax ocherous white with light infuscation anteriorly. Forewing ground color creamy white; basal patch small, primarily indicated by a small grayish-fuscous spot on costa at basal fifth, continued transversely to fold, then inwardly to dorsum as a pale, ill-defined buff line; on middle of costa a large grayish-fuscous blotch continued to middle of cell; at apical third, on costa, a grayish-fuscous spot continued transversely and outwardly to vein 5 as a grayish-buff fascia; at end of cell a small fuscous spot followed outwardly by an ill-defined, irregular, transverse, pale buff fascia; from vein 5 around termen and tornus and along dorsum, a series of short, fine, fuscous strigulae; underside strongly infuscated except along costa; cilia mixed buff and white. Hindwing sordid white shading to and mottled with grayish fuscous at apex and outer margins; cilia sordid white with gray subbasal band. Foreleg creamy white; femur and tibia irrorate with fuscous on outer side; tarsus broadly banded with grayish fuscous; midleg similar to foreleg;

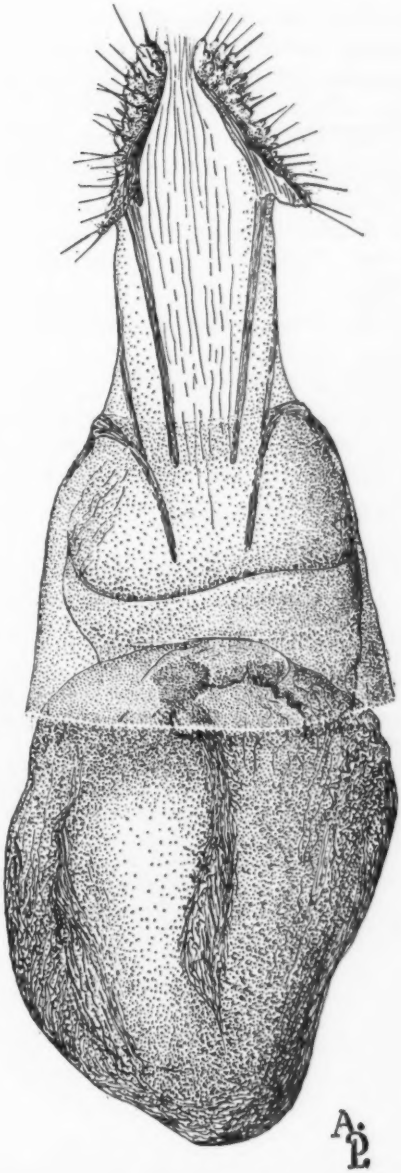


FIGURE 30.—*Phtheochroa arrhostia*, new species: ventral view of female genitalia.

hindleg ocherous white with sparse, grayish-fuscous irroration. Abdomen grayish fuscous dorsally; ventrally ocherous white.

Female genitalia slide JFGC no. 11615. Ostium very wide, slitlike. Antrum narrowly sclerotized. Ductus bursae scarcely definable. Bursa copulatrix with serrate sclerotized area, where it joins ductus bursae, and an elongate, sclerotized portion dorsally; lamella postvaginalis broad, lightly sclerotized.

Holotype: U.S. National Museum No. 69748.

Type-locality: Peru, Cusco, Machu Picchu, 2385 m.

Distribution: Peru.

Described from the female holotype (5.III.1959, J. F. G. Clarke), and one ♀ paratype with the same data.

In placing *arrhostia* in *Phtheochroa* I do so with some hesitation, but there is no other available genus that has a female approaching this. Hubner's *rugosana*, the type of the genus, exhibits the broad ostial opening as in *arrhostia*, but the latter has much more sculpturing in the bursa copulatrix.

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Neotropical Microlepidoptera Series in the *Proceedings*

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paper	*author*	*subject*	*year*	*volume*	*number*
I, II	Clarke	Blastodacnidae and Aegeriidae	1962	113	3457
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V	Obraztsov	The tortricid genus *Proeulia*	1964	116	3501
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XI	Obraztsov	The tortricid genus *Idolatteria*	1966	119	3543
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XVI	Clarke	New species of *Oecophoridae*	1968	125	3654

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By Arthur G. Humes and Ju-Shey Ho [1]

Only one lichomolgid copepod, *Lichomolgus spinulifer* Humes and Frost, 1964, has been reported as an associate of nephtheid octocorals in Madagascar, where it lives on *Lemnalia* sp. This paper deals with six new species of *Lichomolgus* and with *L. spinulifer* washed from various species of Nephtheidae in the region of Nosy Bé in northwestern Madagascar.

All collections were made by A. G. Humes, those in 1960 during an expedition sponsored by the Academy of Natural Sciences of Philadelphia, and those in 1963–64 as part of the U.S. Program in Biology of the International Indian Ocean Expedition.

The study of the specimens has been aided by a grant (GB–5838) from the National Science Foundation of the United States.

All figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. The abbreviations used are: A_1=first antenna, A_2=second antenna, L=labrum, MXPD=maxilliped, and P_1=leg 1.

All descriptions are based on type material. The measurements of the length of the body have been made in all cases from specimens in

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lactic acid and do not include the setae on the caudal rami. The lengths of the segments of the first antenna have been measured along their posterior nonsetiferous margins.

We are indebted to Mme. A. Tixier-Durivault of the Muséum National d'Histoire Naturelle, Paris, for the identifications of the octocorals collected in 1960, and to Dr. J. Verseveldt, Zwolle, The Netherlands, for the determinations of those collected in 1963–64.

The new copepods described in this paper comprise the following:

1. *Lichomolgus varirostratus*, new species—from *Dendronephthya mucronata* (Pütter), *D. regia* Verseveldt, *D. stocki* Verseveldt, and *D. köllikeri* Kükenthal.
2. *Lichomolgus exilipes*, new species—from the same four species of *Dendronephthya*.
3. *Lichomolgus gentilis*, new species—from *Dendronephthya mucronata* (Pütter), *D. stocki* Verseveldt, *D. köllikeri* Kükenthal, *Stereonephthya acaulis* Verseveldt, and *S. papyracea* Kükenthal.
4. *Lichomolgus fissisetiger*, new species—from *Stereonephthya acaulis* Verseveldt, *S. papyracea* Kükenthal, and *Lemnalia elegans* (May).
5. *Lichomolgus cuneipes*, new species—from *Stereonephthya acaulis* Verseveldt.
6. *Lichomolgus aculeatus*, new species—from *Nephthea aberrans* Verseveldt, *N. sphaerophora* Kükenthal, *N. crassa* Kükenthal, *N. tixierae* Verseveldt, and *Litophyton arboreum* Forskål.

The following new hosts are recorded for *Lichomolgus spinulifer* Humes and Frost, 1964:

Lemnalia flava May, *L. elegans* (May), *L. amabilis* Tixier-Durivault, *L. africana* (May), and *Paralemnalia thyrsoides* (Ehrenberg).

Family LICHOMOLGIDAE Kossmann, 1877

Genus *Lichomolgus* Thorell, 1860

Lichomolgus varirostratus, new species

FIGURES 1–31

TYPE MATERIAL.—133 ♀♀, 95 ♂♂, and 7 copepodids from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″ S, 47°45′10″ E, collected Sept. 30, 1964. Holotype ♀, allotype, and 85 paratypes (50 ♀♀ and 35 ♂♂) deposited in the United States National Museum, the same number of paratypes in the Zoölogisch Museum,

Amsterdam, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 168 ♀♀ and 118 ♂♂ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964; 7 ♀♀ and 8 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963; 38 ♀♀, 36 ♂♂, and 4 copepodids from 1 colony, in 2 m, northern end of Nosy Sakatia, near Nosy Bé, Aug. 19, 1963; and 3 ♀♀ and 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Dendronephthya regia* Verseveldt: 5 ♀♀ and 1 ♂ from 1 colony, in 40 m, Banc de Cinq Mètres, west of Nosy Bé, at about 13°23′39″ S, 48°04′00″ E, Aug. 19, 1964. From *Dendronephthya stocki* Verseveldt: 3 ♀♀ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963, and 4 ♀♀ and 2 ♂♂ from 1 colony, in 40 m, Banc de Cinq Mètres, Aug. 19, 1964. From *Dendronephthya köllikeri* Kükenthal: 3 ♀♀ and 9 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′ S, 47°46.5′ E, Sept. 30, 1964.

FEMALE.—Body (fig. 1) with moderately broad prosome. Length 0.83 mm (0.77–0.90 mm) and greatest width (near middle of cephalosome) 0.47 mm (0.43–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.24:1. Segment of first leg separated dorsally and laterally from head by a transverse furrow; lateral areas of this segment rounded posteriorly and not expanded. Lateral areas of segment bearing leg 2 expanded, those of segment of leg 3 expanded and slightly truncated, and those of segment of leg 4 small and rounded.

Segment of leg 5 (fig. 2) about twice as wide as long, 65μ x 120μ. Ventrally between this segment and genital segment a slight intersegmental sclerite. Genital segment (fig. 2) a little longer than wide, 138μ x 118μ, in dorsal view expanded in its midregion, anterior and posterior to which the segment is constricted (anterior constricted area set off ventrally from rest of segment by a weak transverse line). Areas of attachment of egg sacs situated dorsolaterally on posterior part of expanded area. Each area (fig. 3) with 2 naked spiniform setae, both about 11μ in length, and a prominent unguiform process. Three postgenital segments 36μ x 68μ, 26μ x 63μ, and 50μ x 62μ, from anterior to posterior.

Caudal ramus (fig. 4) about as long as wide, its greatest dimensions being 25μ x 28μ when measured dorsally and 29μ x 28μ when measured ventrally. Of the usual 6 setae, outer lateral seta 48μ long, pedicellate dorsal seta 26μ, outermost distal seta 73μ, innermost distal seta 122μ, and the 2 long median terminal setae 208μ (outer) and 290μ (inner) and both inserted between dorsal (unornamented) and ventral (with marginal rows of spinules) flaps. All these setae naked except

innermost distal one, which has a row of hairs along inner edge. A few surficial hairs on ramus.

Dorsal surface of prosome and urosome with minute hairs. Ratio of length of prosome to that of urosome 1.9:1.

Most ovigerous females observed carrying clusters of eggs, as in figure 1, rather than complete sacs; egg sacs delicate and easily broken in preserved specimens. One of the few intact egg sacs (fig. 5) 473μ x 180μ, elongated, reaching nearly to ends of ramal setae, with each egg about 50μ–55μ in diameter.

Rostral area (fig. 6) broadly rounded posteroventrally.

First antenna (fig. 7) 7-segmented, 360μ in length, with third segment showing ventrally a proximal sclerotized area suggesting an intercalary segment. Lengths of segments: 39μ (66μ along anterior margin), 98μ, 26μ, 50μ, 54μ, 37μ, and 28μ respectively. Formula for armature: 4, 13, 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked except for 2 delicately plumose on last segment.

Second antenna (fig. 8) 4-segmented, with last segment moderately elongated, 91μ along its outer edge, 52μ along its inner edge, and 26μ wide. Each of first 2 segments with a small inner seta and surficial spinules as indicated in the figure, third segment with 3 setae (2 subequal and much longer than third), and last segment with 7 elements: 5 short hyaline elements and 2 long slightly unequal recurved claws 101μ and 91μ (measured along greatest axis). All setae naked.

Labrum (fig. 9) with 2 relatively short broadly rounded posteroventral lobes.

Mandible (fig. 10) with basal region distal to constriction bearing on its convex margin a row of spinules followed by a serrated fringe and on its concave margin a row of slender spinules; flagellum elongated with lateral spinules. Paragnath (fig. 11) a small hairy lobe. First maxilla (fig. 12) an elongated segment bearing 3 terminal setae. Second maxilla (fig. 13) 2-segmented, large first segment unarmed, second segment with a small setule on proximal outer margin, a surficial posterior seta barbed along one edge, an inner distal spine with prominent lateral spinules, and the segment produced distally to form a lash with dentiform spines along one edge proximally and fine bilateral spinulation distally. Maxilliped (fig. 14) 3-segmented, first segment with surficial spinules, second with 2 unequal barbed setae and an inner marginal row of small spinules, and third with 2 terminal spiniform barbed setae (producing a bifurcated appearance) and a naked setule. (Articulations of these 2 setae obscure, with inner one perhaps a process rather than an actual seta.)

Area between maxillipeds and first pair of legs (fig. 15) not protuberant; a sclerotized line between bases of maxillipeds.

Legs 1–4 (figs. 16–19) with trimerous rami except for 2-segmented endopod of leg 4. Armature of legs as follows (Roman numerals =spines, Arabic numerals=setae):

P_1	protopod	0–1	1–0	exp	I–0	I–1	III,I,4
				end	0–1	0–1	I,5
P_2	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	I,II,3
P_3	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	I,II,2
P_4	protopod	0–1	1–0	exp	I–0	I–1	II,I,5
				end	0–I	II	

Inner seta on coxa of legs 1–3 long and plumose, but in leg 4 very short (8μ) and naked. Row of hairs present on inner margin of basis in all 4 legs. In leg 1 spinules along proximal margins of outer spines of exopod more prominent than those on distal margins. Endopod of leg 4 shorter than exopod. First segment 49μ x 34μ (including terminal spinous processes) bearing a distal inner barbed spine 32μ long instead of a seta. Second segment 75μ x 29μ (including processes) bearing 2 terminal unequal barbed spines 29μ (outer) and 51μ (inner). Both segments with outer margins haired, and second segment with short hairs along proximal inner margin and a row of minute spinules near insertions of terminal spines.

Leg 5 (fig. 20) with free segment elongated and slightly arcuate, 120μ x 36μ in greatest dimensions, but wider proximally than distally; outer convex surface covered with pointed scales (fig. 21); bearing 2 terminal naked setae 42μ and 65μ in length. Naked seta on body near free segment 52μ, with a group of spinules near its insertion.

Leg 6 probably represented by the 2 spiniform elements near areas of attachment of each egg sac (see fig. 3).

Color in life in transmitted light slightly opaque, eye red, ovary and egg sacs gray.

MALE.—Body (fig. 22) resembling in general form that of female. Length 0.73 mm (0.69–0.75 mm) and greatest width 0.32 mm (0.29–0.33 mm), based on 10 specimens. Ratio of length to width of prosome 1.37:1.

Segment of leg 5 (fig. 23) 41μ x 72μ. Genital segment about as long as wide, 169μ x 160μ, in dorsal view with its lateral borders rounded. No intersegmental sclerite ventrally between these 2 segments. Four postgenital segments 22μ x 52μ, 21μ x 48μ, 14μ x 45μ, and 33μ x 48μ respectively.

Caudal ramus (fig. 23) relatively slightly longer than in female, 24μ x 22μ when measured dorsally, 27μ x 22μ when measured ventrally. Innermost terminal seta with row of hairlike spinules along both margins proximally.

Surface of prosome and urosome with minute hairs as in female. Ratio of length of prosome to that of urosome 1.48:1.

Rostral area (fig. 24) angular, with a minute median posteroventral knob.

First antenna resembling that of female but with 2 aesthetes about 100μ long added on segment 2 and another such aesthete on segment 4 (at points indicated by arrows in fig. 7), so that formula is 4, 13+2 aesthetes, 6, 3+1 aesthete, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Second antenna (fig. 25) resembling that of female, but last segment relatively longer, 99μ along outer edge, 68μ along inner edge, and 21μ wide.

Labrum, mandible, paragnath, first maxilla, and second maxilla like those in female. Maxilliped (fig. 26) slender and 4-segmented (assuming that proximal part of claw represents fourth segment). First segment unornamented. Second segment bearing on medial surface 2 naked setae and 3 rows of spinules, a single row extending the length of segment, other 2 rows close together and restricted to region distal to setae. Third segment very small and unarmed. Claw slender, 185μ long (measured along its axis), with narrow terminal lamella, slight fringe along its distal concave surface, and 2 very unequal setae near its base, one on postero-inner surface 86μ long and finely barbed at its tip, other on anterior surface only 5μ and naked. Claw showing a suggestion of division about midway.

Area between maxillipeds and first pair of legs resembling that of female.

Legs 1–4 segmented as in female and with same spine and setal formula, except for endopod of leg 1 (fig. 27), which has arrangement of 0–1; 0–1; I,I,4. This endopod geniculate, with second and third segments set at an angle to one another. First two segments without outer distal spinous processes. Third segment elongated, nearly as long as first two combined; with 2 terminal spines having strong lateral spinules; a prominent minutely spinose process near insertion of inner of these spines. Last segment of endopod of leg 2 (fig. 28) with 2 of terminal spinous processes larger than in female and bearing numerous minute spines. Legs 3 and 4 like those in female.

Leg 5 (fig. 29) with elongated slender straight free segment, 33μ x 9μ, with nearly parallel sides in dorsal view, bearing a few surficial scales and 2 terminal elements, an outer naked seta 30μ long and an inner spiniform seta 20μ long with coarse short lateral spines. No spinules on body near insertion of free segment.

Leg 6 (fig. 30) a posterolateral flap on ventral surface of genital segment bearing 2 naked setae 22μ and 27μ long.

Spermatophore (fig. 31), attached to female, elongated, 172μ x 78μ without neck. Spermatophores readily extruded from male when placed in lactic acid, as shown in figure 30.

Color in life resembling that of female.

ETYMOLOGY.—The specific name *varirostratus*, from Latin *varius*=different and *rostratus*=furnished with a beak, alludes to the different shape of the rostrum in the two sexes of this species.

COMPARISON WITH RELATED SPECIES.—Two features of *L. varirostratus* serve to distinguish it from all other known species in the genus, namely, the presence of a spine instead of a seta on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna. In only one other species, *L. anomalus* A. Scott, 1909, does the endopod of leg 4 appear to have the formula 0–I, II (based on Scott's fig. 15, pl. LXVII); the usual formula in *Lichomolgus* is 0–1, II. Scott's species differs from the new species, however, in having only one claw on the second antenna. The general structure of the endopod in leg 1 of the male of *L. varirostratus* resembles rather closely that of *L. anomalus*. Scott noted that this geniculate form "is quite distinct from what is usually found in males of this genus."

Two unusually long terminal claws occur on the second antenna in four species—*L. canui* Sars, 1917; *L. ieversi* Thompson and A. Scott, 1903; *L. marginatus* Thorell, 1860; and *L. tenuicornis* Brady, 1910—but in all of these species the formula for the endopod of leg 4 is 0–1, II, thus readily separating them from the new species from Madagascar.

Lichomolgus exilipes, new species

FIGURES 32–55

TYPE MATERIAL.—31 ♀♀ and 18 ♂♂ from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″S, 47°45′10″E, collected Sept. 30, 1964. Holotype ♀, allotype, and 35 paratypes (25 ♀♀ and 10 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 15 ♀♀ and 8 ♂♂ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964, and 6 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963. From *Dendronephthya regia* Verseveldt: 2 ♀♀ from 1 colony, in 40 m, Banc de Cinq Mètres, west of Nosy Bé, at about 13°23′30″S, 48°04′00″E, Aug. 19, 1964. From *Dendronephthya stocki* Verseveldt: 1 ♀ and 6 ♂♂ from 1 colony,

in 40 m, Banc de Cinq Mètres, Aug. 19, 1964. From *Dendronephthya köllikeri* Kükenthal: 7 ♀♀ and 12 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964.

FEMALE.—Body (fig. 32) a little less broadened than in *L. varirostratus*. Length 0.99 mm (0.91–1.09 mm) and greatest width 0.50 mm (0.46–0.52 mm), based on 10 specimens. Ratio of length to width of prosome 1.3:1. Segment of first leg separated dorsally and laterally from head by a furrow. Lateral areas of segments of legs 1–4 shaped as in figure.

Segment of leg 5 measuring 73μ x 151μ. Between this segment and genital segment a slight ventral intersegmental sclerite. Genital segment (fig. 33) slightly longer than wide, 172μ x 156μ, in dorsal view constricted anteriorly and posteriorly but expanded in midregion. A pair of crescentic sclerotized ridges on anterior dorsal surface. Areas of attachment of egg sacs located dorsolaterally at level of expanded part of segment. Each area (fig. 34) bearing 2 naked setae 11μ and 20μ in length, with a small digitiform process between them. Three postgenital segments 34μ x 81μ, 23μ x 68μ, and 34μ x 70μ, from anterior to posterior.

Caudal ramus (fig. 35) only slightly longer than wide, its greatest dimensions being 30μ x 25μ when measured dorsally and 33μ x 25μ when measured ventrally. Outer lateral seta 109μ and naked, pedicellate dorsal seta 22μ and naked, outermost distal seta 180μ and naked, innermost distal seta 283μ with inner lateral spinules, and the 2 long median terminal setae 418μ (outer) and 550μ (inner), both inserted between dorsal (unornamented) and ventral (with marginal row of spinules) flaps, and bearing lateral spinules in their midregions. A delicate setule on proximal outer edge of ramus, and a few surficial hairs dorsally.

Dorsal surface of prosome and urosome with minute hairs. Ratio of length of prosome to that of urosome 2.24:1.

Egg sacs in most ovigerous females observed broken, as in figure 32. One intact egg sac measuring 430μ x 176μ, elongated, reaching well beyond ends of caudal rami, and containing many small eggs, each about 40μ in diameter.

Rostral area (fig. 36) linguiform, rounded posteroventrally.

First antenna (fig. 37) resembling in general form that of *L. varirostratus*, with same segmentation and formula for armature, but longer, 480μ. Lengths of segments: 36μ (77μ along anterior margin), 133μ, 32μ, 70μ, 75μ, 56μ, and 36μ respectively. All setae naked.

Second antenna (fig. 38) also resembling that of *L. varirostratus*, with similar segmentation and armature. Last segment 135μ along its outer edge, 86μ along its inner edge, and 31μ wide. Three setae on

third segment 42μ, 21μ, and 42μ from proximal to distal, with distalmost spiniform and minutely barbed along one edge. Both claws about 135μ in length.

Labrum (fig. 39) with 2 posteroventral lobes less broadly rounded than in *L. varirostratus*.

Mandible (fig. 40) resembling that of *L. varirostratus*, but with distinct constriction separating basal region into two parts, convex margin of distal part bearing spinules and projected distally as a short blunt process. Paragnath a small lobe bearing hairs. First maxilla (fig. 41) bearing a small subterminal element in addition to 3 terminal ones. Second maxilla (fig. 42) and maxilliped (fig. 43) segmented and armed as in *L. varirostratus*, but slight differences in ornamentation of elements as shown in figures.

Area between maxillipeds and first pair of legs (fig. 44) not protuberant; a sclerotized line between bases of maxillipeds.

Legs 1–4 (figs. 45–48) segmented as in *L. varirostratus*, with same spine and setal formula. Inner seta on coxa of leg 4 short (12μ) and naked. Inner margin of basis of leg 4 without hairs. In leg 1 spinules along proximal margins of outer spines of exopod longer and coarser than those on distal margins. Endopod of leg 4 only slightly shorter than exopod. First segment 56μ x 35μ (including terminal spinous processes), bearing an inner distal minutely barbed spine 43μ long. Second segment 111μ x 30μ (greatest dimensions including processes), bearing 2 terminal barbed spines 39μ (outer) and 77μ (inner); a few minute spinules along inner margin of segment.

Leg 5 (fig. 49) with free segment much elongated, slender, and slightly arcuate, 172μ x 23μ (width 35μ at level of proximal inner expansion). Outer convex surface bearing pointed scales. Two terminal naked setae 122μ and 190μ in length. Naked seta on body near free segment 55μ, with a few minute spinules not far from its insertion.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 34).

Color in life in transmitted light as in *L. varirostratus*.

MALE.—Body (fig. 50) resembling that of female in general form. Length 0.78 mm (0.73–0.81 mm) and greatest width 0.34 mm (0.30–0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.4:1.

Segment of leg 5 measuring 36μ x 101μ. Genital segment (fig. 51) about as long as wide, 221μ x 216μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 22μ x 56μ, 17μ x 55μ, 11μ x 51μ, and 24μ x 56μ respectively.

Caudal ramus (fig. 51) somewhat shorter than in female, 22μ x 24μ dorsally, 23μ x 24μ ventrally. Innermost terminal seta with row of

spinules on both sides. Outermost terminal seta with inner spinules proximally.

Surfaces of prosome and urosome with minute hairs as in female. Ratio of length of prosome to that of urosome 1.43:1.

Rostral area as in female.

First antenna resembling that of female, but with 2 long aesthetes added on second segment and another aesthete on fourth segment, so that formula is same as for male of *L. varirostratus*.

Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla similar to those in female. Maxilliped (fig. 52) less slender than in *L. varirostratus*, but segmented and armed similarly. Claw slender and 170μ along its axis; proximal region of claw slightly swollen and faintly striated.

Area between maxilliped and first pair of legs as in female.

Legs 1–4 segmented as in *L. varirostratus*, with spine and setal formula as in male of that species. Endopod of leg 1 (fig. 53) slightly geniculate. Third segment elongated, with outer terminal spine straight, having lateral spinules and hyaline tip, inner terminal spine bent, with strong spinules along its inner distal edge; spinous process between these 2 spines enlarged and finely spinose. No obvious sexual dimorphism in legs 2–4.

Leg 5 (fig. 54) with a very elongated slender straight free segment, 55μ x 11μ, bearing on its outer surface a few scales and terminally an outer naked seta 56μ long and an inner spine 29μ long with short lateral spinules. No spinules on body near insertion of free segment.

Leg 6 similar to that in *L. varirostratus*, with 2 naked setae 41μ and 78μ in length.

Spermatophore (fig. 55), attached to female, elongated, 174μ x 91μ, not including neck.

Color in life as in *L. varirostratus*.

ETYMOLOGY.—The specific name *exilipes*, from Latin *exilis*=slender and *pes*=foot, refers to the elongated slender form of leg 5 in both sexes of this species.

COMPARISON WITH RELATED SPECIES.—Like *L. varirostratus*, this species may be distinguished from all other known species in the genus on the basis of a combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus exilipes may readily be separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae on the caudal rami, the form of the fifth legs and the genital segment in the female, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

Lichomolgus gentilis, new species

FIGURES 56–69

TYPE MATERIAL.—20 ♀♀ and 28 ♂♂ from a colony of *Dendronephthya mucronata* (Pütter), in 4 m, on the northeastern coast of Antany Mora, Isles Radama, Madagascar, 14°06′10″S, 47°45′10″E, collected Sept. 30, 1964. Holotype ♀, allotype, and 36 paratypes (14 ♀♀ and 22 ♂♂) deposited in the United States National Museum and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Dendronephthya mucronata:* 4 ♀♀ from 6 colonies, in 1 m, off Ampombilava, Nosy Bé, Madagascar, Sept. 26, 1964; 10 ♀♀ and 19 ♂♂ from 1 colony, in 1 m, Tany Kely, a small island south of Nosy Bé, June 23, 1963; 2 ♀♀ from 1 colony, in 2 m, northern end of Nosy Sakatia, near Nosy Bé, Aug. 19, 1963; and 2 ♀♀ and 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Dendronephthya köllikeri* Kükenthal: 15 ♀♀ and 19 ♂♂ from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964. From *Dendronephthya stocki* Verseveldt: 1 ♂ from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963. From *Stereonephthya acaulis* Verseveldt: 1 ♀, 2 ♂♂, and 45 copepodids from 1 colony, in 20 m, Tany Kely, Dec. 20, 1963; 5 ♀♀, 22 ♂♂, and 1 copepodid from 1 colony, in 10 m, Tany Kely, Aug. 21, 1964; 11 ♀♀ and 8 ♂♂ from 1 colony, in 1 m, off Ampombilava, Nosy Bé, Sept. 26, 1964; and 15 ♀♀, 9 ♂♂, and 1 copepodid from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964. From *Stereonephthya papyracea* Kükenthal: 39 ♀♀ and 52 ♂♂ from 1 colony, in 6 m, Tany Kely, Aug. 26, 1963.

FEMALE.—Body (fig. 56) with moderately broad prosome. Length 0.91 mm (0.82–1.03 mm) and greatest width 0.47 mm (0.45–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.28:1.

Segment of leg 5 measuring 52μ x 159μ. Between this segment and genital segment no ventral intersegmental sclerite visible. Genital segment (fig. 57) nearly as long as wide, 148μ x 159μ, in dorsal view expanded in its anterior three-fourths but constricted posteriorly. Areas of attachment of egg sacs located dorsolaterally on posterior part of expanded region. Each area (fig. 58) with a slender naked seta 13μ long, a spiniform unilaterally barbed seta 18μ long, and an adjacent slender setiform process. Three postgenital segments 26μ x 86μ, 20μ x 82μ, and 25μ x 77μ from anterior to posterior.

Caudal ramus (fig. 57) a little shorter than wide, its greatest dimensions being 25μ x 32μ when measured dorsally and 27μ x 32μ when measured ventrally. Outer lateral seta 143μ long and naked, pedicellate dorsal seta 39μ and naked, outermost distal seta 235μ and naked, innermost distal seta 352μ with row of spinules along inner edge, and the 2 long median terminal setae 517μ (outer) and 583μ (inner), both inserted between dorsal (unornamented) and

ventral (with marginal row of spinules) flaps, and both with strong coarse lateral spinules in midregion (these spinules much stronger than in *L. exilipes*).

Ratio of length of prosome to that of urosome 2.5:1.

Most ovigerous females observed carrying only clusters of eggs as in figure 56. One of few intact egg sacs measuring 462μ x 198μ, elongated oval, reaching far beyond caudal rami, with each egg about 44μ in diameter.

Rostral area and first antenna (453μ long) resembling those of *L. exilipes*. Second antenna (fig. 59) formed in general like that of *L. exilipes*, but 3 elements on third segment 35μ, 24μ, and 25μ from proximal to distal. Last segment 130μ along its outer edge, 83μ along its inner edge, and 31μ wide. Two terminal claws different in form and length, one being slender and 143μ along its axis, other stout and 127μ. (Apparently some variation in lengths of claws, with one female 153μ and 117μ on one side and 146μ and 130μ on other. In one female from *Stereonephthya acaulis* 120μ and 99μ, and in another 125μ and 107μ. In all cases, however, longer claw slender, shorter one stout.)

Labrum as in *L. exilipes*. Mandible (fig. 60) without blunt process on convex margin of basal region as in *L. exilipes*. Paragnath, first maxilla, and second maxilla similar to those in *L. exilipes*. Maxilliped (fig. 61) differing only slightly from that species.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line connecting bases of maxillipeds.

Legs 1–4 segmented as in 2 previous species, with same spine and setal formula. Inner seta on coxa of leg 4 short (10μ) and naked. Inner margin of basis of leg 4 without hairs. In leg 1 (fig. 62) and leg 2 spinules along proximal margins of outer spines of exopod longer and stouter than those on distal margins. Endopod of leg 4 (fig. 63) shorter than exopod. First segment 55μ x 34μ (including terminal spinous processes), bearing an inner distal finely barbed spine 35μ long. Second segment 99μ x 34μ (greatest dimensions including processes), bearing 2 terminal spines, outer 44μ and finely barbed, inner 79μ with lateral spinules; a row of long hairs along proximal two-thirds of inner margin of segment.

Leg 5 (fig. 64) with elongated free segment, 143μ x 20μ (width taken at level of proximal inner expansion). Outer convex surface with pointed scales. Two terminal naked setae 99μ and 148μ in length. Seta on body near insertion of free segment 40μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 58).

Color in life in transmitted light as in 2 previous species.

MALE.—Body (fig. 65) resembling that of female in general aspect. Length 0.72 mm (0.69–0.77 mm) and greatest width 0.34 mm (0.32–0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.36:1.

Segment of leg 5 measuring 39μ x 104μ. Genital segment (fig. 66) as long as wide, 200μ x 203μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 15μ x 61μ, 17μ x 57μ, 12μ x 56μ, and 22μ x 58μ respectively.

Caudal ramus as in female, but proportions slightly different, 20μ x 24μ dorsally, 27μ x 24μ ventrally. As in *L. exilipes*, outermost terminal seta with inner spinules proximally and innermost terminal seta with row of spinules on both sides.

Ratio of length of prosome to that of urosome 1.7:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added (length of proximalmost=130μ) so that formula is same as for males of 2 previous species. Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those of female. Maxilliped (fig. 67) with general form similar to *L. exilipes*, but ornamentation of major setae slightly different. Claw slender and 172μ along its axis.

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 2 previous species, with spine and setal formula as in males of those species. Endopod of leg 1 (fig. 68) only slightly geniculate. Third segment moderately elongated, with outer terminal spine straight, having lateral spinules and small hyaline tip, inner terminal spine slightly bent (not as strongly so as in *L. exilipes*) with moderately strong spinules along its inner distal edge; spinous process between these 2 spines as in *L. exilipes*. No obvious sexual dimorphism in legs 2–4, except that endopod of leg 4 (fig. 69) has slightly different proportions: first segment 33μ x 25μ, with spine 25μ, second segment 70μ x 22μ (more elongated than in female, ratio 3.2:1 instead of 2.9:1 as in that sex), with 2 terminal spines 31μ and 61μ.

Leg 5 (fig. 66) with elongated free segment, 57μ x 11μ, without pronounced proximal inner expansion, bearing on its outer surface a few scales and terminally an outer naked seta 71μ and an inner barbed spine 19μ. No spinules on body near insertion of free segment.

Leg 6 similar to those in 2 previous species, with 2 naked setae 50μ and 82μ in length.

Spermatophore, attached to female, as in *L. exilipes*.

Color in life as in 2 previous species.

ETYMOLOGY.—The specific name *gentilis*, from Latin=belonging to the same gens or clan, alludes to the close relationship of this species with *L. exilipes*.

COMPARISON WITH RELATED SPECIES.—Like *L. varirostratus* and *L. exilipes* this species may be distinguished from all other members of the genus by the combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus gentilis may be readily separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae on the caudal rami, the form of the genital segment in the female, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

From *L. exilipes* the new species may be separated by the coarser lateral spinules on the two long setae on the caudal rami, the more unequal nature of the two claws on the second antenna, the lack of a blunt process on the inner margin of the mandible, and the form of the fifth legs and the genital segment in the female.

Lichomolgus fissisetiger, new species

FIGURES 70–83

TYPE MATERIAL.—24 ♀♀ and 20 ♂♂ from a colony of *Stereonephthya acaulis* Verseveldt, in 2 m, Ambafaho, Nosy Bé, Madagascar, collected Sept. 25, 1964. Holotype ♀, allotype, and 34 paratypes (18 ♀♀ and 16 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Stereonephthya acaulis:* 45 ♀♀ and 89 ♂♂ from 1 colony, in 10 m, Tany Kely, a small island south of Nosy Bé, Aug. 21, 1964; 22 ♀♀, 9 ♂♂, and 2 copepodids from 1 colony, in 1 m, off Ampombilava, Nosy Bé, Sept. 26, 1964; and 9 ♀♀ and 16 ♂♂ from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964. From *Stereonephthya papyracea* Kükenthal: 53 ♀♀, 80 ♂♂, and 92 copepodids from 1 colony, in 6 m, Tany Kely, Aug. 26, 1963. From *Lemnalia elegans* (May): 3 ♀♀ from 1 colony, in 1 m, Pte. Lokobe, Nosy Bé, Oct. 16, 1960.

FEMALE.—Body (fig. 70) similar to that of *L. exilipes* and *L. gentilis*. Length 0.99 mm (0.92–1.03 mm) and greatest width 0.49 mm (0.46–0.51 mm), based on 10 specimens. Ratio of length to width of prosome 1.5:1.

Segment of leg 5 measuring 65μ x 143μ. Between this segment and genital segment a small ventral intersegmental sclerite. Genital segment (fig. 71) slightly shorter than wide, 127μ x 143μ, in dorsal view with its lateral borders rounded. Areas of attachment of egg sacs located almost laterally (only slightly dorsally) in posterior half of segment. Each area (fig. 72) with 2 small naked setae about 11μ long and an adjacent small unguiform process. Three postgenital segments 26μ x 82μ, 21μ x 73μ, and 26μ x 70μ from anterior to posterior.

Caudal ramus (fig. 73) shorter than wide, its greatest dimensions being 20μ x 28μ when measured dorsally, 21μ x 28μ when measured ventrally. Outer lateral seta 83μ long and naked, pedicellate dorsal seta 25μ and naked, outermost distal seta 117μ with proximal inner spinules, innermost distal seta 208μ with spinules along both sides, and the 2 long median terminal setae 440μ (outer) and 590μ (inner), both inserted between dorsal (unornamented) and ventral (with marginal row of spinules) flaps, and both with lateral spinules in midregion (these spinules not as strong as in *L. gentilis*, and more like those of *L. exilipes*).

Ratio of length of prosome to that of urosome 2.9:1.

Egg sac (fig. 70) 550μ x 209μ, elongated, reaching far beyond ends of caudal rami, containing many eggs, each about 45μ in diameter.

Rostral area and first antenna (428μ long) similar to those of *L. exilipes* and *L. gentilis*. Second antenna (fig. 74) resembling that of *L. gentilis*, but differing in details. Three naked elements on third segment 35μ, 21μ, and 20μ in length from proximal to distal. Last segment 94μ along outer margin, 60μ along inner margin, and 25μ wide. Two terminal claws unequal, not as long as in *L. gentilis*, one 92μ along its axis and slender, the other 77μ and stouter.

Labrum as in *L. exilipes* and *L. gentilis*. Mandible (fig. 75) similar to that in *L. gentilis*, but showing an even more pronounced constriction of basal region. Paragnath and first maxilla as in *L. exilipes* and *L. gentilis*. Second maxilla (fig. 76) resembling *L. exilipes* and *L. gentilis*, but spinulation of lash and distal seta slightly different. Maxilliped as in *L. exilipes* and *L. gentilis*.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line between bases of maxillipeds.

Legs 1–4 segmented as in 3 previous species, with same spine and setal formula. Leg 1 similar to that of *L. exilipes* and *L. gentilis*. Legs 2 and 3 like those of *L. exilipes*. Leg 4 (fig. 77) resembling that of *L. gentilis*. Endopod shorter than exopod. First segment 42μ x 32μ (including terminal spinous processes), with inner distal minutely barbed spine 31μ long. Second segment 90μ x 29μ (greatest dimensions including processes), outer terminal spine 34μ with finely barbed fringe, inner 72μ with more coarsely spinulose fringe. Proximal inner margin of this segment with row of very short spinules.

Leg 5 (fig. 78) with elongated free segment having prominent inner basal expansion. Greatest length 148μ, width 42μ at expansion, 23μ immediately distal to expansion, and 16μ near tip. Outer surface with narrow scalelike spines. Two terminal naked setae 72μ and 110μ (the latter with a narrow membrane in its midregion). Seta on body near insertion of free segment about 50μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 72).

Color in life in transmitted light somewhat opaque, eye red, ovary dark gray, egg sacs gray.

MALE.—Body (fig. 79) resembling that of female in general form. Length 0.78 mm (0.74–0.81 mm) and greatest width 0.29 mm (0.27–0.30 mm), based on 10 specimens. Ratio of length to width of prosome 1.48:1.

Segment of leg 5 measuring 36μ x 91μ. Genital segment (fig. 80) as long as wide, 185μ x 185μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 17μ x 50μ, 14μ x 52μ, 12μ x 50μ, and 19μ x 52μ respectively.

Caudal ramus resembling that of female but smaller, 14μ x 22μ dorsally, 18μ x 22μ ventrally.

Ratio of length of prosome to that of urosome 1.62:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 3 previous species, so that formula is same as for those males. Aesthetes much longer than in preceding species, proximalmost one 240μ in length. Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla like those in female. Maxilliped resembling in general form that of *L. gentilis*, but one of setae on inner surface of second segment terminating in several pointed spiniform elements (fig. 81). Claw 133μ in length (measured along its axis).

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 3 previous species, with spine and setal formula as in those males. Endopod of leg 1 (fig. 82) only slightly geniculate. Third segment resembling that of *L. gentilis*. Legs 2–4 as in female.

Leg 5 (see fig. 80) resembling that of *L. exilipes*, with free segment 52μ x 9μ, terminally with inner spine 18μ and barbed, outer seta 68μ and naked.

Leg 6 (fig. 83) similar to that in 3 preceding species, with 2 naked setae 44μ and 66μ in length.

Spermatophore not observed.

Color in life in transmitted light more translucid than in female, eye red, genital segment hyaline.

ETYMOLOGY.—The specific name *fissisetiger*, from Latin *fissus*=split and *setiger*=bearing a seta, refers to the nature of the seta on the second segment of the maxilliped in the male of this species.

COMPARISON WITH RELATED SPECIES.—Like the three preceding species *L. fissisetiger* may be distinguished from all other members of the genus by the combination of two characters: the spine (instead

of a seta) on the first segment of the endopod of leg 4 and the two unusually long terminal claws on the second antenna.

Lichomolgus fissisetiger may be separated from *L. varirostratus* by the form of the rostrum, the presence of lateral spinules on the two long setae of the caudal rami, the form of the genital segment and leg 5 in the female, the long aesthetes on the first antenna of the male, and the structure of the two spines on the last segment of the endopod of leg 1 in the male.

It may be distinguished from *L. exilipes* by the form of the genital segment and leg 5 in the female, the more unequal nature of the two claws on the second antenna, the lack of a blunt process on the inner margin of the mandible, the peculiar split seta on the second segment of the maxilliped in the male, and the long aesthetes on the first antenna of the male.

From *L. gentilis* the new species may be distinguished by the form of the genital segment and leg 5 in the female, the pronounced constriction of the basal region of the mandible, the split seta on the second segment of the maxilliped in the male, and the long aesthetes on the first antenna of the male.

Lichomolgus cuneipes, new species

FIGURES 84–96

TYPE MATERIAL.—39 ♀♀ and 18 ♂♂ from a colony of *Stereonephthya acaulis* Verseveldt, in 1 m, off Ampombilava, Nosy Bé, Madagascar, collected Sept. 26, 1964. Holotype ♀, allotype, and 46 paratypes (32 ♀♀ and 14 ♂♂) deposited in the United States National Museum, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS (all from *Stereonephthya acaulis*).—6 ♀♀ and 3 ♂♂ from 1 colony, in 2 m, Ambafaho, Nosy Bé, Sept. 25, 1964; 9 ♀♀ and 10 ♂♂ from 1 colony, in 10 m, Tany Kely, a small island south of Nosy Bé, Aug. 21, 1964; and 11 ♀♀ and 9 ♂♂ from 1 colony, in 2 m, Andraikarekabe, Nosy Komba, near Nosy Bé, Oct. 9, 1964.

FEMALE.—Body (fig. 84) resembling that of *L. fissisetiger*. Length 0.94 mm (0.89–0.98 mm) and greatest width 0.48 mm (0.45–0.49 mm), based on 10 specimens. Ratio of length to width of prosome 1.56:1.

Segment of leg 5 measuring 65μ x 138μ. Between this segment and genital segment a small ventral intersegmental sclerite. Genital segment (fig. 85) about as long as wide, 125μ x 120μ, in dorsal view with its lateral borders somewhat irregular. Areas of attachment of egg sacs located dorsolaterally in middle of segment. Each area (fig. 86) with 2 small naked setae about 8μ long with a pointed sclerotized process between them. Three postgenital segments 26μ x 75μ, 21μ x 71μ, and 26μ x 71μ from anterior to posterior.

Caudal ramus (fig. 87) shorter than wide, its greatest dimensions being 22μ x 30μ when measured dorsally, 24μ x 30μ when measured ventrally. Outer lateral seta 75μ long, pedicellate dorsal seta 28μ, outermost distal seta 112μ, innermost distal seta 203μ, and the 2 long median terminal setae 380μ (outer) and 495μ (inner), both inserted between dorsal and ventral flaps as in previous species. All setae naked.

Ratio of length of prosome to that of urosome 2.78:1.

Egg sac (fig. 84) 462μ x 187μ, elongated, reaching far beyond ends of caudal rami, containing many eggs, each about 45μ in diameter.

Rostral area (fig. 88) broadly rounded posteroventrally.

First antenna (410μ long) similar to that of *L. exilipes*, the segments 31μ (61μ along anterior edge), 133μ, 28μ, 57μ, 56μ, 42μ, and 32μ in length respectively. Second antenna (fig. 89) with 4 segments having same formula for armature as in previous species. Three elements on third segment consisting of 2 naked setae 22μ and 23μ and a spiniform seta 11μ long and very finely spinulose. Last segment 74μ along outer margin, 40μ along inner margin, and 22μ wide. Two terminal claws not as long as in 4 previous species and unequal, one being 46μ and slender, other 43μ and much stouter.

Labrum as in *L. exilipes*. Mandible as in *L. fissisetiger*. Paragnath and first maxilla as in *L. exilipes*. Second maxilla (fig. 90) resembling in general form that of *L. fissisetiger*, but 4–5 central teeth on lash much stouter than others. Maxilliped much like that of *L. gentilis*.

Area between maxillipeds and first pair of legs not protuberant, with a sclerotized line between bases of maxillipeds.

Legs 1–4 segmented as in 4 previous species, with same spine and setal formula. Legs 1–3 closely resembling those of *L. exilipes*. Leg 4 (fig. 91) with endopod shorter than exopod, its first segment 41μ x 28μ (including terminal spinous processes) with inner distal finely barbed spine 30μ, second segment 90μ x 24μ (greatest dimensions including processes), outer terminal spine 29μ with finely barbed margins, inner 63μ with coarsely barbed fringe on outer margin and very slightly barbed fringe on inner margin. Inner margin of this segment with very short spinules.

Leg 5 (fig. 92) with elongated free segment having a prominent inner basal expansion directed distally. (Shape of this expansion varying somewhat in different individuals, as in figures 93 and 94.) Length of segment 134μ, width at expansion 40μ, width just distal to expansion 26μ. Outer surface with narrow scalelike spines. Two terminal setae 70μ and 88μ (the latter with a narrow membrane as in *L. fissisetiger*). Seta on body near insertion of segment about 40μ long and slightly plumose; a few small spinules near this seta.

Leg 6 probably represented by the 2 setae near areas of attachment of each egg sac (see fig. 86).

Color in life in transmitted light as in *L. fissisetiger*.

MALE.—Body (fig. 95) resembling that of *L. fissisetiger*. Length 0.73 mm (0.69–0.77 mm) and greatest width 0.26 mm (0.22–0.28 mm), based on 10 specimens. Ratio of length to width of prosome 1.73:1.

Segment of leg 5 measuring 34μ x 81μ. Genital segment (fig. 96) about as long as wide, 169μ x 164μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 16μ x 46μ, 16μ x 45μ, 13μ x 44μ, and 18μ x 47μ respectively.

Caudal ramus similar to that of female but smaller, 17μ x 22μ dorsally, 19μ x 22μ ventrally.

Ratio of length of prosome to that of urosome 1.7:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 4 previous species, so that formula is same as for those males. Aesthetes long as in *L. fissisetiger*, proximalmost 200μ in length. Second antenna like that of female, but with a few small spinules along inner margins of first, second, and fourth segments.

Labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped as in *L. gentilis*, with claw 146μ in length (measured along its axis).

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 4 previous species, with spine and setal formula as in those males. Endopod of leg 1 as in *L. fissisetiger*. Legs 2–4 as in female.

Leg 5 as in *L. exilipes*, with free segment 51μ x 8μ, its seta 53μ and its spine 19μ in length.

Leg 6 similar to that of *L. fissisetiger*, with 2 naked setae 26μ and 53μ long.

Spermatophore not observed.

Color in life as in female.

ETYMOLOGY.—The specific name *cuneipes*, from Latin *cuneus*=a wedge and *pes*=a foot, alludes to the wedgelike form of the inner basal expansion of leg 5 in the female of this species.

COMPARISON WITH RELATED SPECIES.—*Lichomolgus cuneipes* may be differentiated from all other previously known species in the genus by the combination of two characters: the spine (instead of a seta) on the first segment of the endopod of leg 4 and the second antenna bearing terminally two claws and five small hyaline elements.

Lichomolgus cuneipes may be separated from all four species described above by the shorter and more unequal two claws on the

second antenna, by the nature of the teeth on the lash of the second maxilla, and by the form of the fifth legs in the female.

***Lichomolgus aculeatus*, new species**

FIGURES 97–113

TYPE MATERIAL.—69 ♀♀, 116 ♂♂, and 39 copepodids from a colony of *Nephthea aberrans* Verseveldt, in 10 m, Tany Kely, a small island south of Nosy Bé, Madagascar, collected Aug. 21, 1964. Holotype ♀, allotype, and 154 paratypes (54 ♀♀ and 100 ♂♂) deposited in the United States National Museum, 20 paratypes (10 ♀♀ and 10 ♂♂) in the Zoölogisch Museum, Amsterdam, and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS.—From *Nephthea sphaerophora* Kükenthal: 33 ♀♀, 17 ♂♂, and 11 copepodids from 1 colony, in 3 m, Pte. Lokobe, Nosy Bé, Oct. 16, 1960. From *Nephthea crassa* Kükenthal: 27 ♀♀, 46 ♂♂, and 33 copepodids from 1 colony, in 2 m, Pte. Mahatsinjo, Nosy Bé, Aug. 8, 1960; 51 ♀♀ and 97 ♂♂ from 1 colony, in 2 m, Tany Kely, Aug. 26, 1960. From *Nephthea tixierae* Verseveldt: 70 ♀♀, 92 ♂♂, and 100 copepodids from 1 colony, in 8 m, Nosy Ovy, Isles Radama, 13°59′S, 47°46.5′E, Sept. 30, 1964. From *Litophyton arboreum* Forskål: 189 ♀♀ and 47 ♂♂ from 1 colony, in 3 m, Andraikarekabe, western shore of Nosy Komba, near Nosy Bé, Oct. 9, 1964.

FEMALE.—Body (fig. 97) with moderately broad prosome. Length 1.26 mm (1.21–1.32 mm) and greatest width 0.57 mm (0.55–0.59 mm), based on 10 specimens. Segment of leg 1 separated from head by a distinct furrow. Epimeral areas of segments of legs 2 and 3 angular. Ratio of length to width of prosome 1.49:1.

Segment of leg 5 measuring 83μ x 190μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment (fig. 98) longer than wide, 221μ x 195μ, its lateral areas not expanded. Areas of attachment of egg sacs situated dorsally near middle of segment. Each area with 2 minute naked setae. Three postgenital segments 75μ x 127μ, 44μ x 107μ, and 39μ x 110μ from anterior to posterior.

Caudal ramus (fig. 99) about 2.2 times longer than wide, 100μ x 48μ when measured dorsally, 110μ x 48μ when measured ventrally. Outer lateral seta 122μ long and naked; all other setae with prominent lateral spinules. Pedicellate dorsal seta 55μ, outermost distal seta 148μ, innermost distal seta 161μ, and the 2 long median terminal setae 213μ (outer) and 230μ (inner), both inserted between dorsal and ventral flanges bearing marginal spinules. Dorsal surface of ramus with fine ornamentation as in figure.

Ratio of length of prosome to that of urosome 1.7:1.

Egg sac (fig. 97) approximately 380μ x 200μ, reaching to insertion of caudal ramus, containing 8–11 eggs, each about 100μ in diameter.

Rostral area broadly rounded posteroventrally.

First antenna (433μ long) similar to that of *L. spinulifer* Humes and Frost, 1964, except that all setae are naked; segments 29μ (68μ along anterior edge), 125μ, 31μ, 64μ, 68μ, 46μ, and 31μ respectively. Second antenna (fig. 100) with 4 segments having same formula for armature as in previous species. Three elements on third segment consisting of 2 naked setae 49μ and 40μ and a spiniform seta 35μ barbed along one edge. Last segment 109μ along outer margin, 73μ along inner margin, and 30μ wide. Two terminal claws elongated, slender, and nearly equal, 140μ and 133μ.

Labrum (fig. 101) with 2 posteroventral lobes. Mandible (fig. 102) similar to that of *L. spinulifer*, but with a pointed prominence on its convex margin distal to proximal spinules. Paragnath and first maxilla as in *L. spinulifer*. Second maxilla (fig. 103) similar to *L. spinulifer*, but with first segment broadened so that convex margin of appendage is angular; long spinules on proximal edge of distalmost seta on second segment; small setule on proximal outer area of second segment (as in *L. spinulifer*). Maxilliped (fig. 104) resembling that of *L. spinulifer*, but differing in fine ornamentation; small seta on third segment (as in *L. spinulifer*).

Area between maxillipeds and first pair of legs as in *L. spinulifer*, with a sclerotized line between bases of maxillipeds as in that species.

Legs 1–4 segmented as in 5 previous species, with same spine and setal formula, and closely resembling those of *L. spinulifer*. Endopod of leg 4 (fig. 105) only slightly shorter than exopod, its first segment 55μ x 42μ (including terminal spinous processes) with an inner distal plumose seta 104μ long, second segment 125μ x 35μ (greatest dimensions including processes), outer terminal spine 25μ and finely barbed, inner 78μ with a finely serrated fringe. Outer margin of second segment with row of spinules (lacking distinct articulations) and inner margin smooth, as in *L. spinulifer*.

Leg 5 (fig. 106) similar to that of *L. spinulifer*, elongated free segment having a small proximal inner expansion. Length of segment 151μ, width at expansion 49μ, width near tip 16μ. Outer surface with scalelike spines. Two terminal naked setae 39μ and 88μ. Seta on body near insertion of segment 45μ and naked.

Leg 6 probably represented by the 2 setae near areas of attachment of egg sac.

Color in life in transmitted light opaque, eye red, ovary gray, egg sacs reddish gray.

MALE.—Body (fig. 107) resembling in general form that of female. Length 1.01 mm (0.96–1.07 mm) and greatest width 0.36 mm (0.35–

0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.56:1.

Segment of leg 5 measuring 44μ x 107μ. Genital segment (fig. 108) somewhat longer than wide, 239μ x 213μ. No ventral intersegmental sclerite between these segments. Four postgenital segments 26μ x 65μ, 23μ x 65μ, 18μ x 63μ, and 23μ x 70μ respectively.

Caudal ramus similar to that of female, 83μ x 39μ dorsally, 85μ x 39μ ventrally.

Ratio of length of prosome to that of urosome 1.45:1.

Rostral area as in female. First antenna similar to that of female, but with 3 aesthetes added as in 5 previous species, so that formula is same as for those males; aesthetes resembling those of *L. spinulifer*. Second antenna (fig. 109) resembling that of female, but with prominent spinules on inner margins of first 2 segments and small spinules added on segments 3 and 4 as in figure.

Labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped (fig. 110) resembling that of *L. spinulifer*, with claw 224μ along its axis.

Area between maxillipeds and first pair of legs as in female.

Legs 1–4 segmented as in 5 previous species, with spine and setal formula as in those males. Endopod of leg 1 (fig. 111) with long terminal spine recurved and concave inwardly, bearing 2 rows of strong spinules: outer spine short and differentially barbed on its 2 margins. Legs 2–4 as in female.

Leg 5 (fig. 112) with free segment 55μ x 10μ (extremes in 4 males 53μ–59μ x 9μ–11μ), its seta 44μ and naked, its spine 20μ with an outer fringe; seta on body near insertion of free segment 35μ and naked.

Leg 6 similar to that of *L. spinulifer*, the 2 small naked setae about 8μ long.

Spermatophore (fig. 113), attached to female, elongated, 195μ x 83μ, not including neck.

Color in life as in female.

ETYMOLOGY.—The specific name *aculeatus*, from Latin=provided with prickles, refers to the nature of the terminal spine on the endopod of leg 1 in the male of this species.

COMPARISON WITH RELATED SPECIES.—*Lichomolgus aculeatus* differs from all five species described above in having a seta (instead of a spine) on the first segment of the endopod of leg 4. The new species appears to be closely related to *L. spinulifer* Humes and Frost, 1964, from *Lemnalia* sp. at Nosy Bé, yet differs from it in several significant features: the relatively shorter caudal ramus (2.2:1, instead of 3.3:1 as in *L. spinulifer*), the long terminal claws on the second antenna, the small pointed process on the convex side of the mandible,

and the concave spinulose spine on the last segment of the endopod in the male.

Lichomolgus spinulifer Humes and Frost, 1964

This species has been previously recorded from *Lemnalia* sp. at Nosy Bé, Madagascar (Humes and Frost, 1964).

NEW HOST RECORDS.—From *Lemnalia flava* May: 211 ♀♀, 133 ♂♂, and 26 copepodids from 1 colony, in 1 m, Pte. Ambarionaomby, Nosy Komba, near Nosy Bé, Dec. 14, 1963. From *Lemnalia elegans* (May): 815 ♀♀, 1018 ♂♂, and 230 copepodids from several colonies, in 15 cm, Boloboxo, Nosy Faly, east of Nosy Bé, May 13, 1964. From *Lemnalia amabilis* Tixier-Durivault: 22 ♀♀, 26 ♂♂, and 15 copepodids from 1 colony, in 3 m, Pte. Ambarionaomby, Nosy Komba, Oct. 3, 1960. From *Lemnalia africana* (May): 59 ♀♀, 55 ♂♂, and 3 copepodids from 1 colony, in 2 m, Pte. Ambarionaomby, Nosy Komba, Sept. 27, 1964. From *Paralemnalia thyrsoides* (Ehrenberg): 60 ♀♀, 62 ♂♂, and 12 copepodids from 1 colony, in 3 m, Antsamantsara, northwest of Madirokely, Nosy Bé, Sept. 20, 1964.

These specimens conform completely with paratypes of *L. spinulifer*. The figures of Humes and Frost (1964) should be modified in certain details as follows: in their figures 142 and 160 of the second antenna, another minute element is present near the bases of the two terminal claws, making five such elements in all; in their figure 147 of the female second maxilla, there is a small seta on the proximal outer area of the second segment, and the distalmost seta on this segment has a few minute inner spinules near its tip; in their figure 148 of the female maxilliped, a small seta is present near the two terminal elements; and in their figures 151–154 (female) and 162 (male) of legs 1–4, the outer distal corner of the coxa bears a few small spinules.

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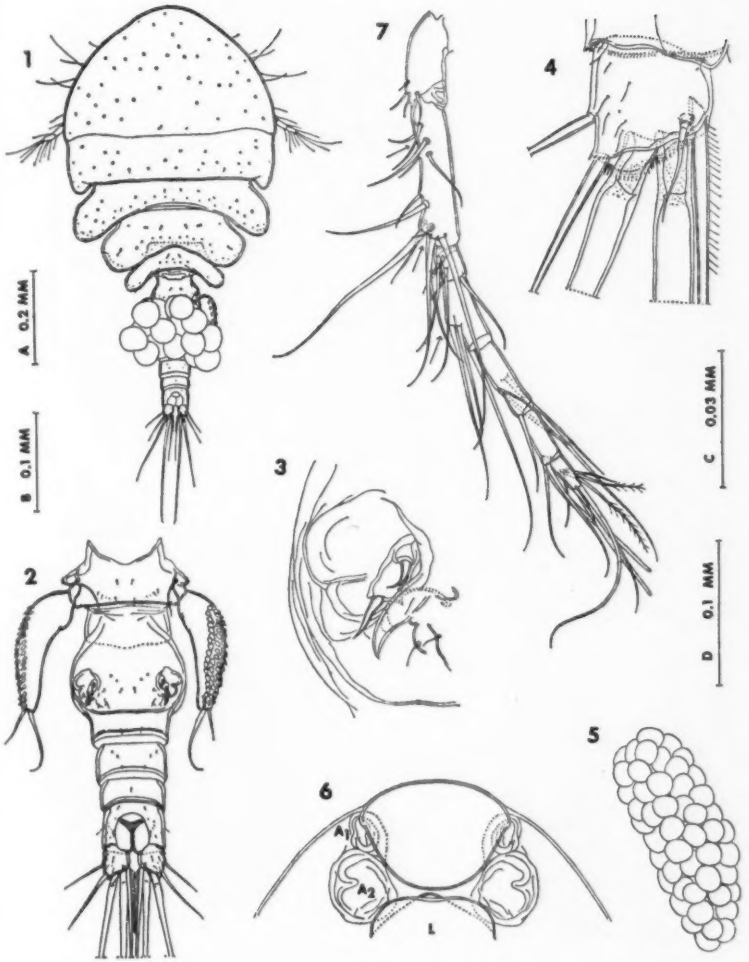
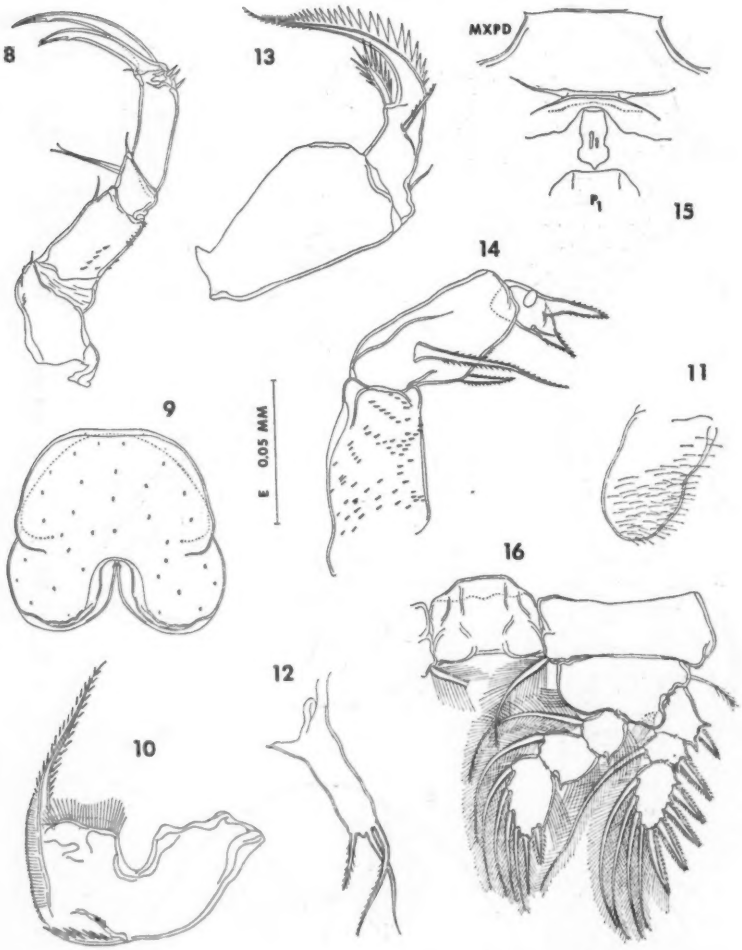
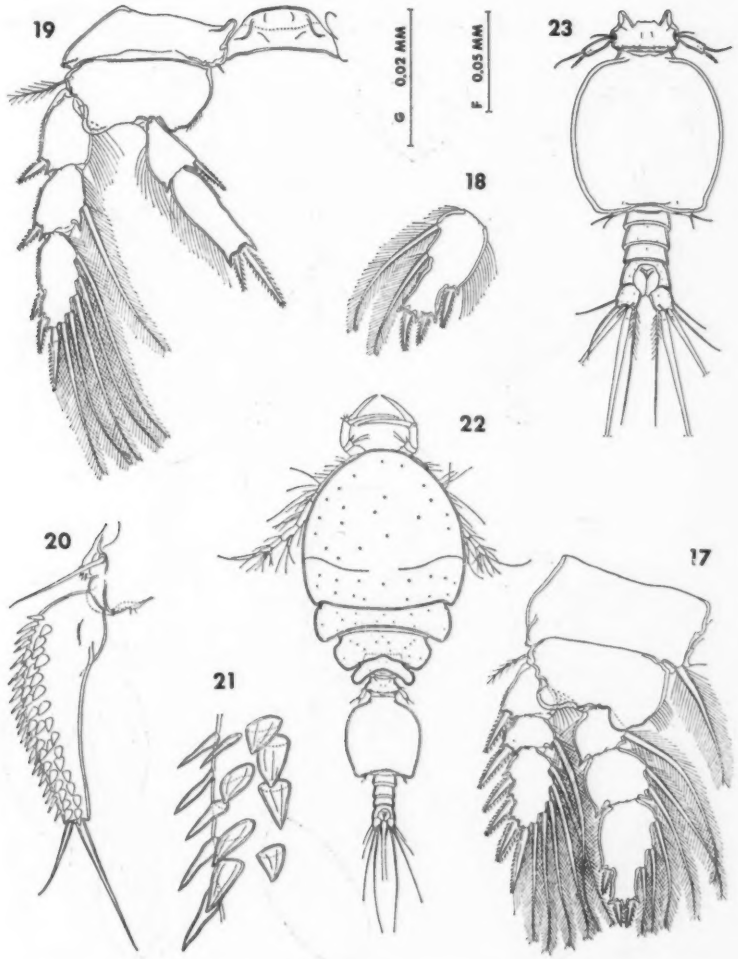


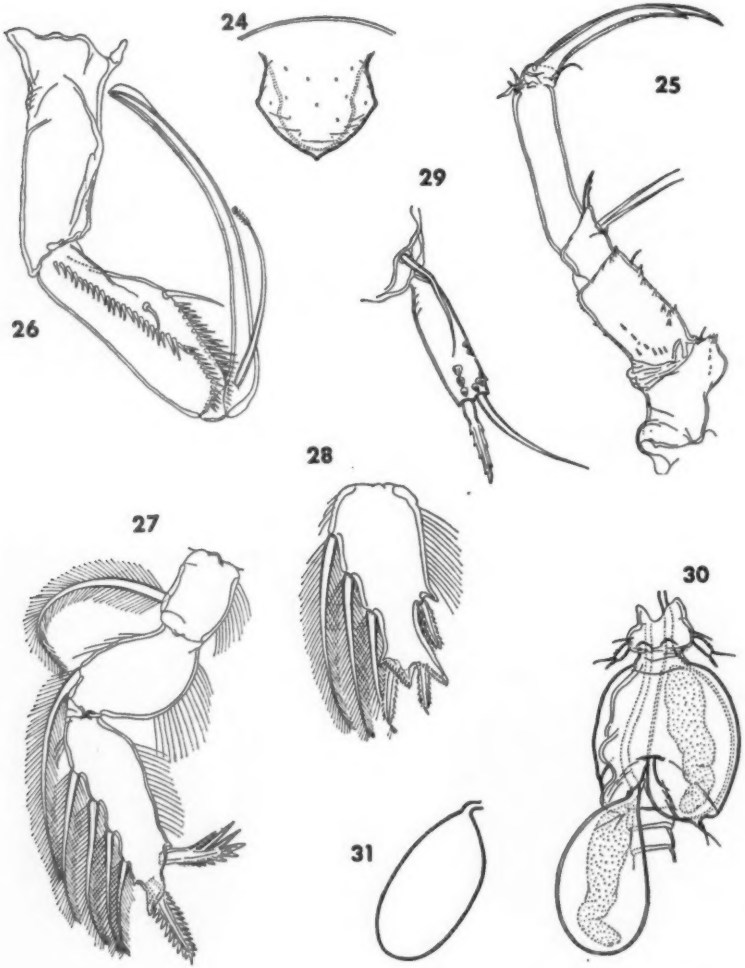
FIGURES 1–7.—*Lichomolgus varirostratus*, new species, female: 1, body, dorsal (A); 2, urosome, dorsal (B); 3, area of attachment of egg sac, dorsal (C); 4, caudal ramus, dorsal (C); 5, egg sac, dorsal (A); 6, rostral area, anteroventral (B); 7, first antenna, dorsal (D).



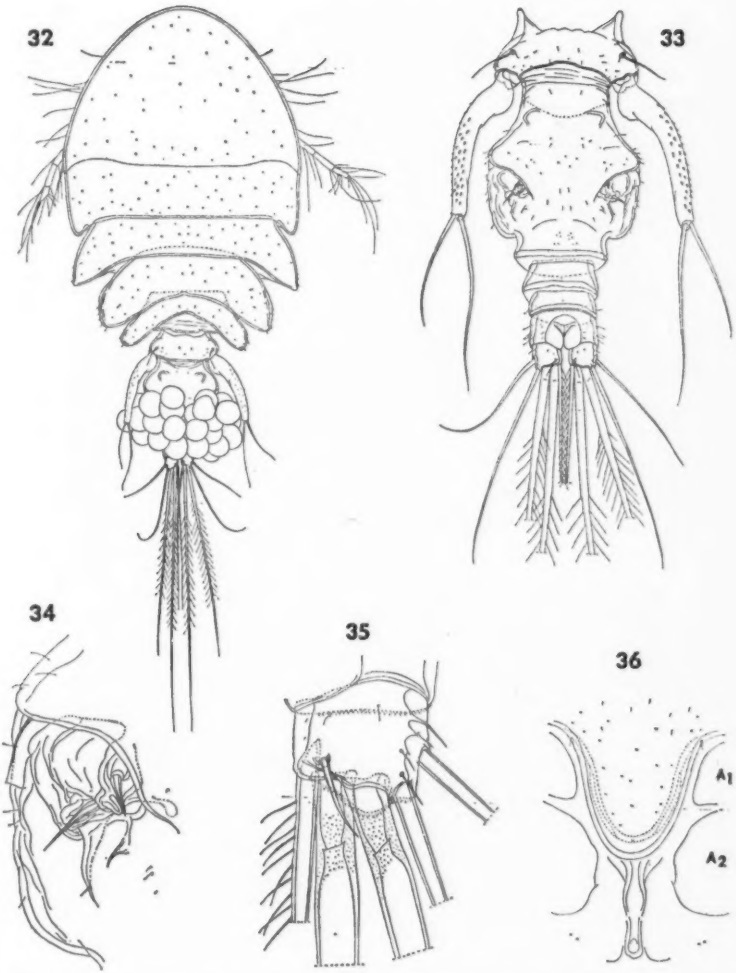
FIGURES 8–16.—*Lichomolgus varirostratus*, new species, female: 8, second antenna, anterior (inner) (D); 9, labrum, ventral (D); 10, mandible, posterior (E); 11, paragnath, ventro-inner (C); 12, first maxilla, anterior (E); 13, second maxilla, posterior (E); 14, maxilliped, postero-inner (E); 15, area between maxillipeds and first pair of legs, ventral (D); 16, leg 1 and intercoxal plate, anterior (D).



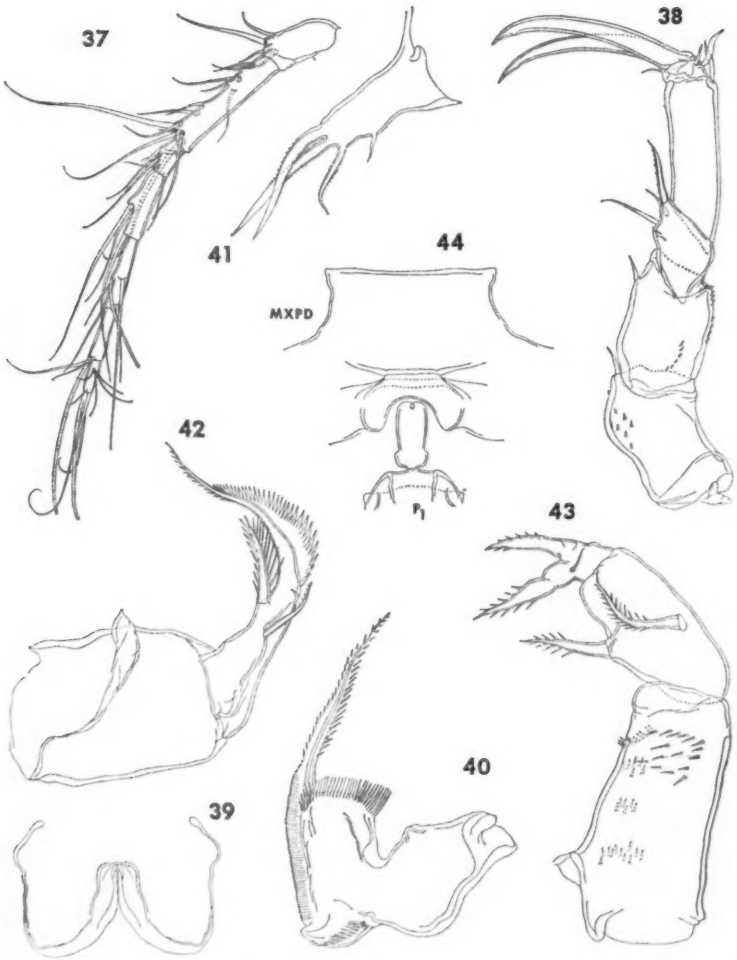
FIGURES 17–23.—*Lichomolgus varirostratus*, new species, female: 17, leg 2, anterior (D); 18, last segment of endopod of leg 3, anterior (D); 19, leg 4 and intercoxal plate, anterior (D); 20, leg 5, dorsal (F); 21, scalelike spines on leg 5, dorso-outer (G). Male: 22, body, dorsal (A); 23, urosome, dorsal (B).



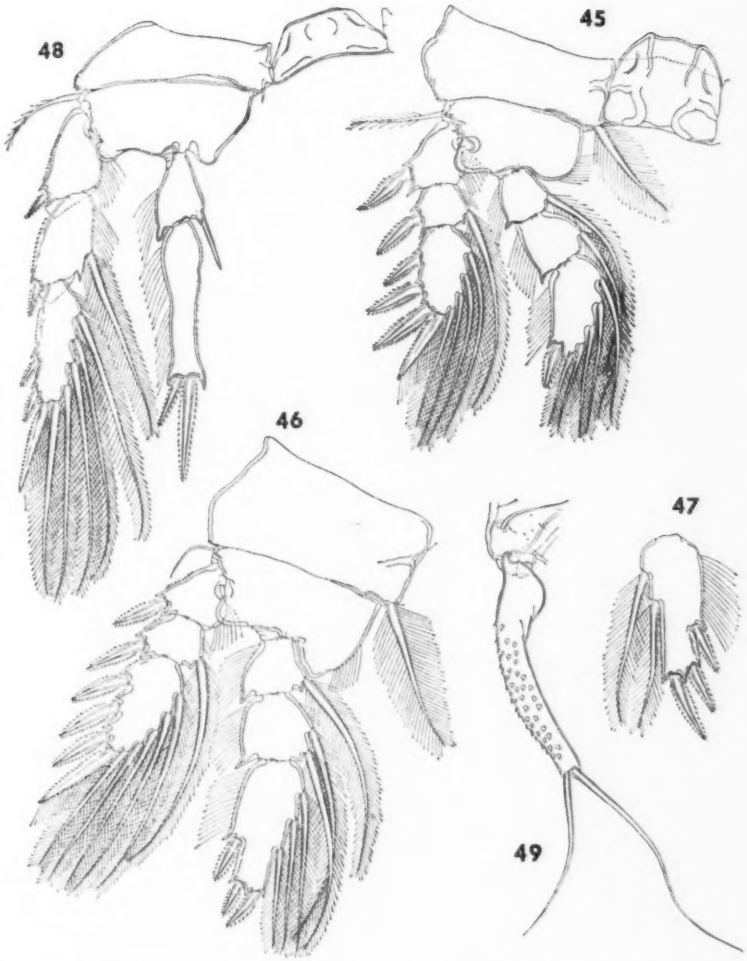
FIGURES 24–31.—*Lichomolgus varirostratus*, new species, male: 24, rostral area, ventral (D); 25, second antenna, anterior (inner) (F); 26, maxilliped, postero-inner (F); 27, endopod of leg 1, anterior (E); 28, last segment of endopod of leg 2, anterior (E); 29, leg 5, dorsal (C); 30, anterior part of urosome, showing extrusion of spermatophore in lactic acid, ventral (B); 31, spermatophore, attached to female, lateral (B).



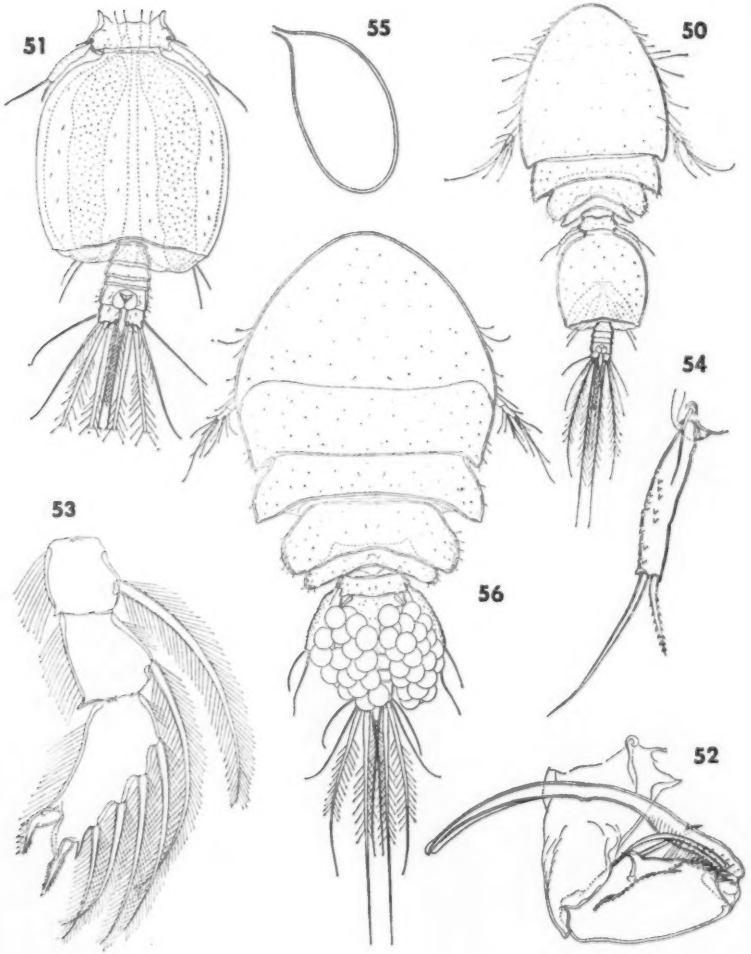
FIGURES 32–36.—*Lichomolgus exilipes*, new species, female: 32, body, dorsal (A); 33, urosome, dorsal (B); 34, area of attachment of egg sac, dorsal (E); 35, caudal ramus, dorsal (C); 36, rostral area, ventral (D).



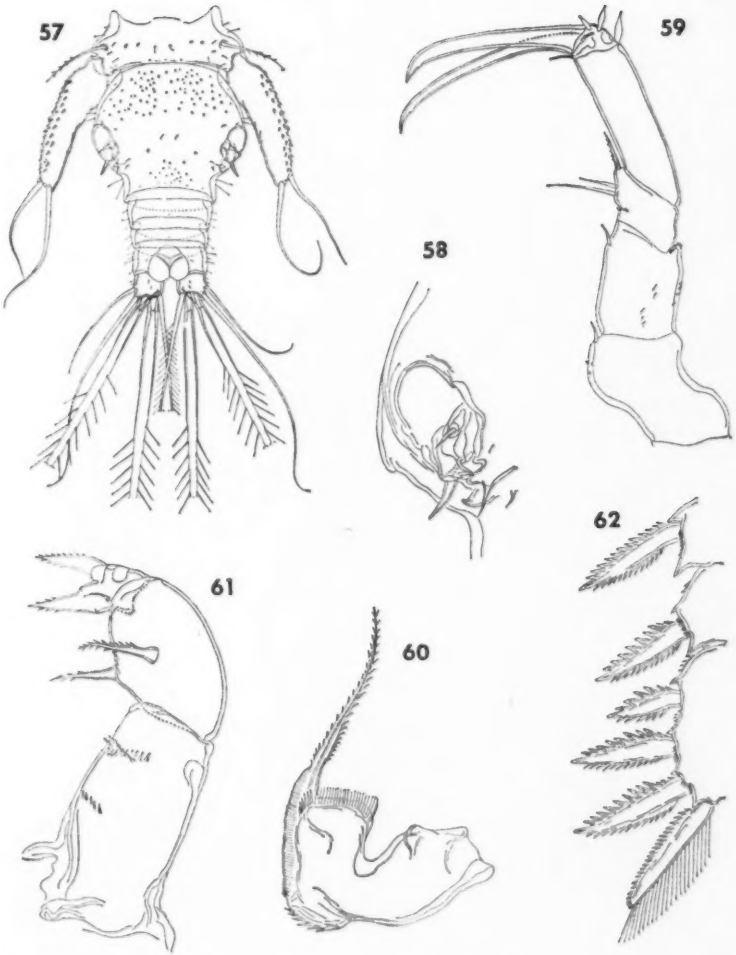
FIGURES 37–44.—*Lichomolgus exilipes*, new species, female: 37, first antenna, ventral (B); 38, second antenna, anterior (inner) (D); 39, labrum, ventral (F); 40, mandible, posterior (E); 41, first maxilla, posterior (E); 42, second maxilla, postero-inner (E); 43, maxilliped, postero-inner (E); 44, area between maxillipeds and first pair of legs, ventral (D).



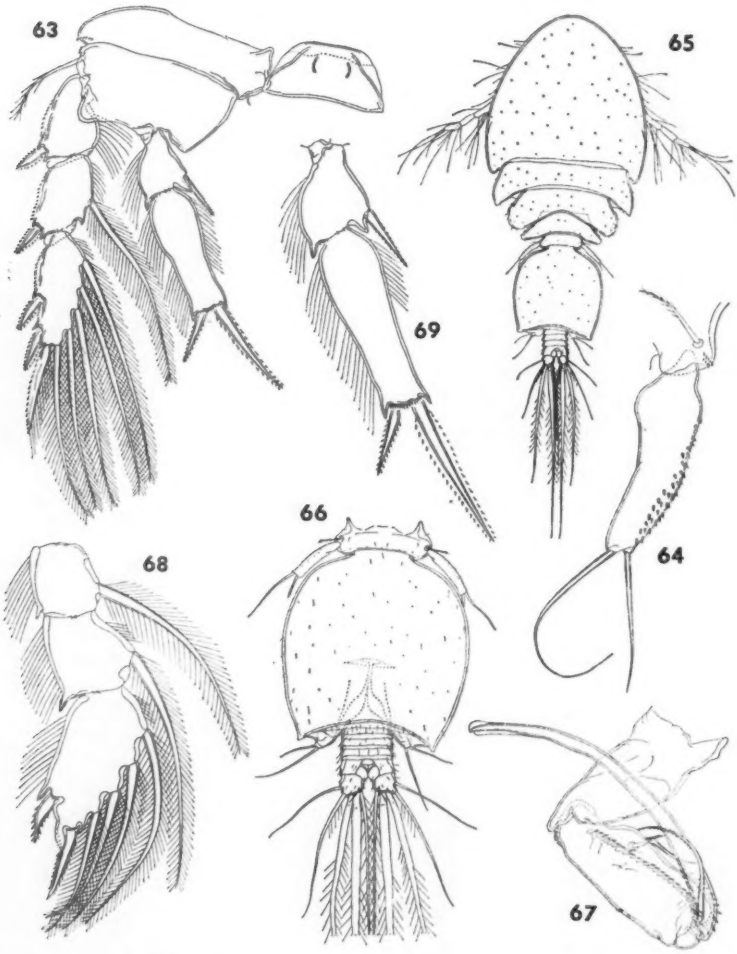
FIGURES 45–49.—*Lichomolgus exilipes*, new species, female: 45, leg 1 and intercoxal plate, anterior (D); 46, leg 2, anterior (D); 47, last segment of endopod of leg 3, anterior (D); 48, leg 4 and intercoxal plate, anterior (D); 49, leg 5, dorsal (D).



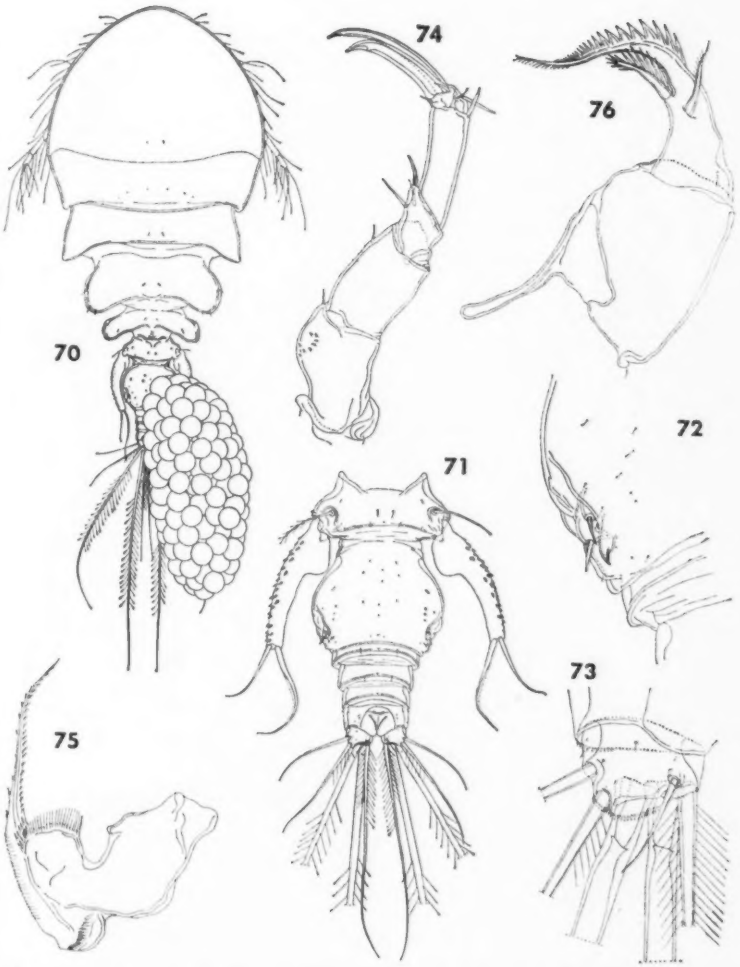
FIGURES 50–56.—*Lichomolgus exilipes*, new species, male: 50, body, dorsal (A); 51, urosome, dorsal (B); 52, maxilliped, postero-inner (F); 53, endopod of leg 1, anterior (E); 54, leg 5, dorsal (E); 55, spermatophore, attached to female, dorsal (B). *Lichomolgus gentilis*, new species, female: 56, body, dorsal (A).



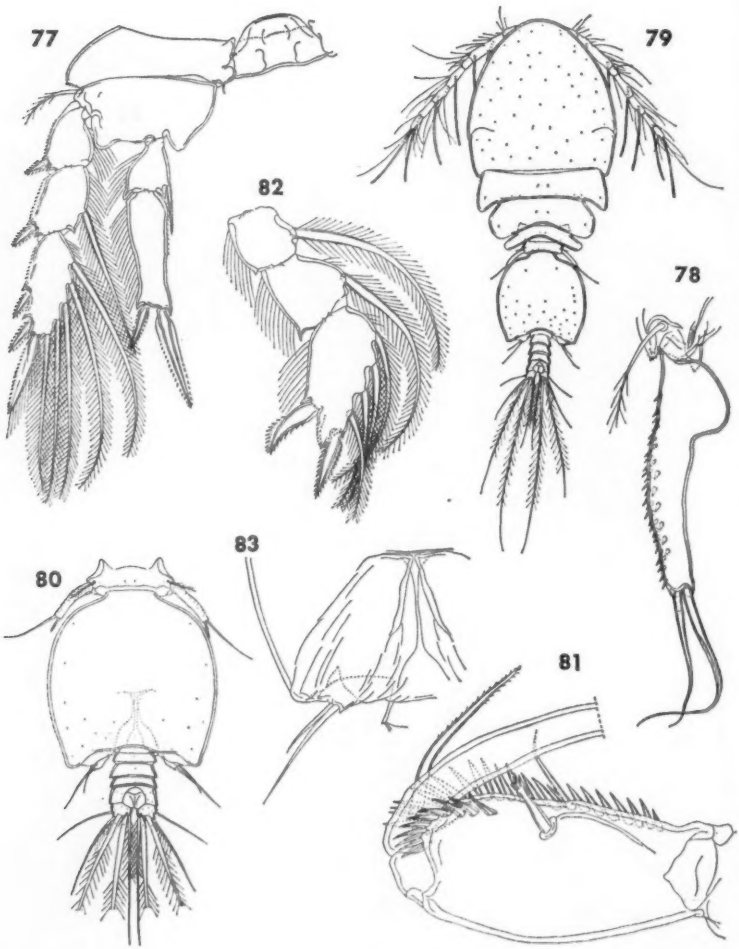
FIGURES 57–62.—*Lichomolgus gentilis*, new species, female: 57, urosome, dorsal (B); 58, area of attachment of egg sac, dorsal (E); 59, second antenna, anterior (inner) (D); 60, mandible, posterior (E); 61, maxilliped, postero-inner (E); 62, spines on exopod of leg 1, anterior (E).



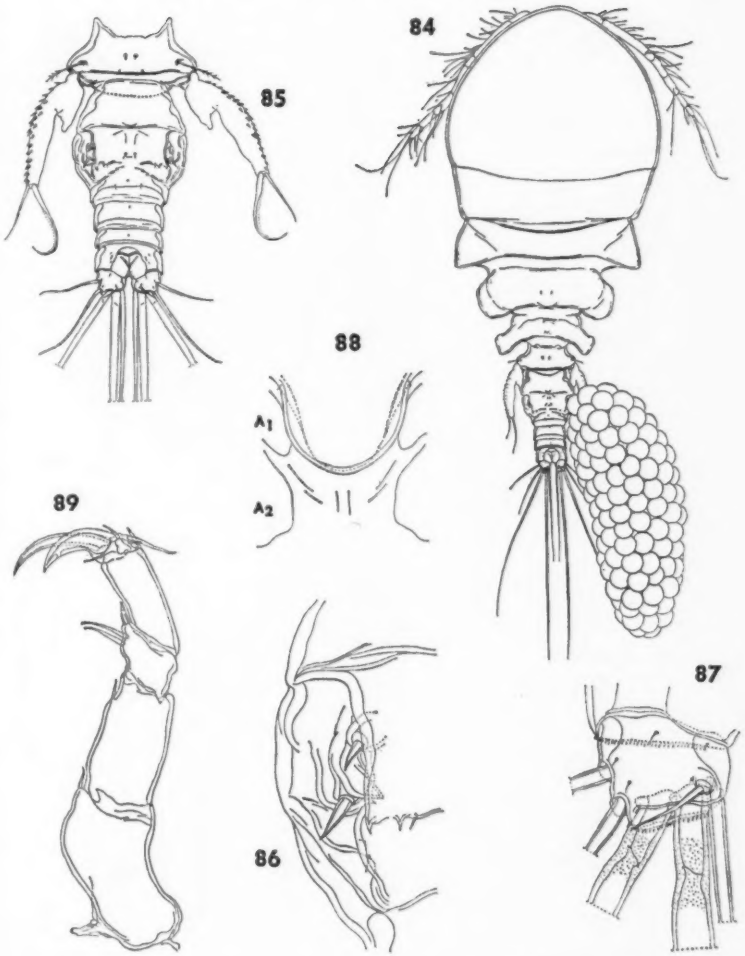
FIGURES 63–69.—*Lichomolgus gentilis*, new species, female: 63, leg 4 and intercoxal plate, anterior (D); 64, leg 5, dorsal (D). Male: 65, body, dorsal (A); 66, urosome, dorsal (B); 67, maxilliped, postero-inner (F); 68, endopod of leg 1, anterior (E); 69, endopod of leg 4, anterior (E).



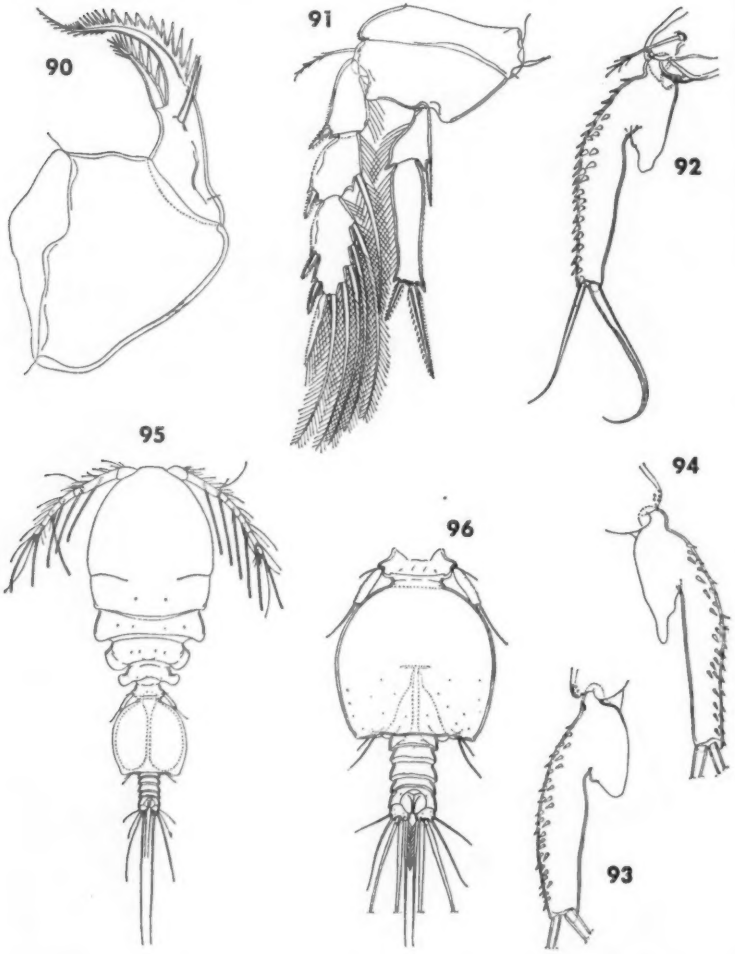
FIGURES 70–76.—*Lichomolgus fissisetiger*, new species, female: 70, body, dorsal (A); 71, urosome, dorsal (B); 72, area of attachment of egg sac, dorsal (E); 73, caudal ramus, dorsal (C); 74, second antenna, anterior (inner) (D); 75, mandible, posterior (E); 76, second maxilla, posterior (E).



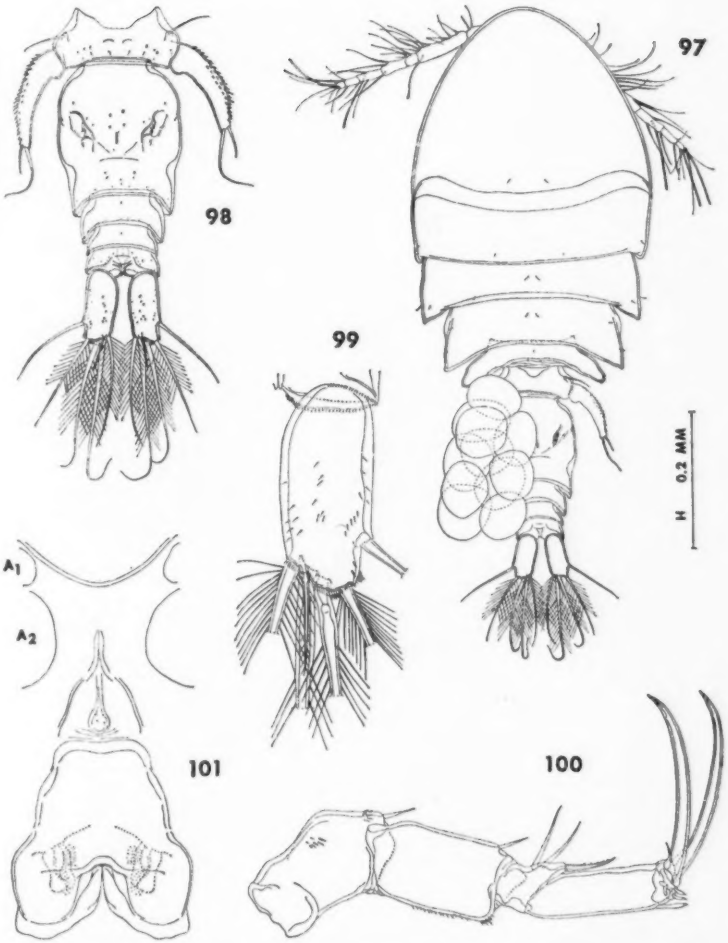
FIGURES 77–83.—*Lichomolgus fissisetiger*, new species, female: 77, leg 4 and intercoxal plate, anterior (D); 78, leg 5, dorsal (F). Male: 79, body, dorsal (A); 80, urosome, dorsal (B); 81, maxilliped, second and third segments and proximal part of claw, ventro-outer (C); 82, endopod of leg 1, anterior (E); 83, leg 6, ventral (F).



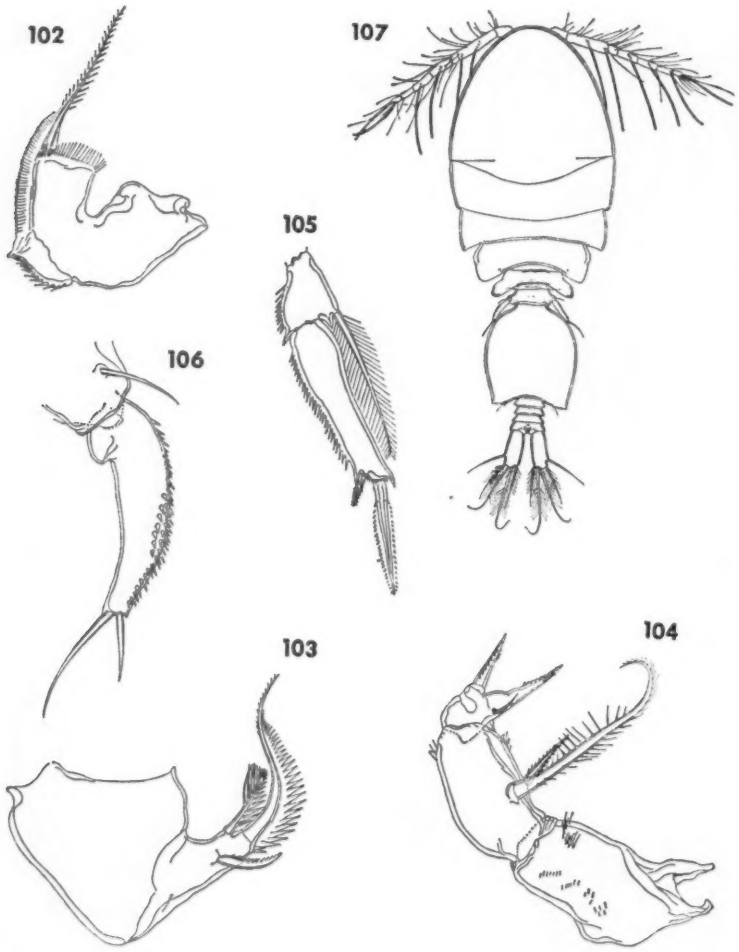
FIGURES 84–89.—*Lichomolgus cuneipes*, new species, female: 84, body, dorsal (A); 85, urosome, dorsal (B); 86, area of attachment of egg sac, dorsal (C); 87, caudal ramus, dorsal (C); 88, rostral area, ventral (D); 89, second antenna, anterior (inner) (F).



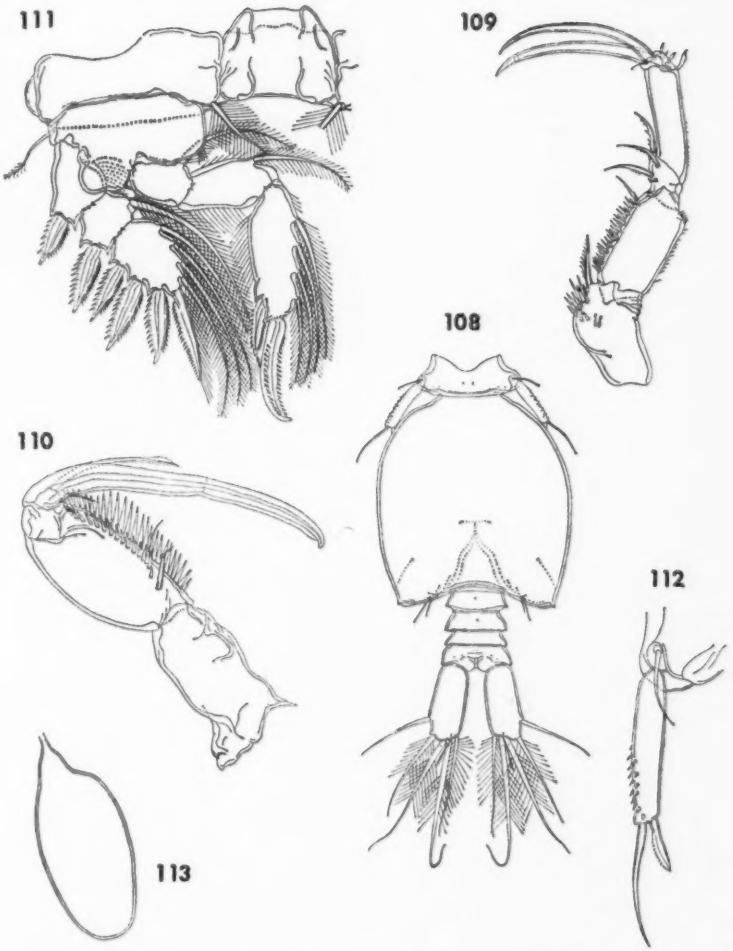
FIGURES 90–96.—*Lichomolgus cuneipes*, new species, female: 90, second maxilla, postero-inner (E); 91, leg 4, anterior (D); 92, leg 5, dorsal (F); 93, free segment of leg 5, dorsal (F); 94, free segment of leg 5, dorsal (F). Male: 95, body, dorsal (A); 96, urosome, dorsal (B).



FIGURES 97–101.—*Lichomolgus aculeatus*, new species, female: 97, body, dorsal (A); 98, urosome, dorsal (H); 99, caudal ramus, dorsal (F); 100, second antenna, anterior (inner) (D); 101, rostral area and labrum, ventral (D).



FIGURES 102–107.—*Lichomolgus aculeatus*, new species, female: 102, mandible, posterior (F); 103, second maxilla, posterior (F); 104, maxilliped, posterior (F); 105, endopod of leg 4, anterior (D); 106, leg 5, dorsal (D). Male: 107, body, dorsal (A).



FIGURES 108–113.—*Lichomolgus aculeatus*, new species, male: 108, urosome, dorsal (B); 109, second antenna, posterior (outer) (D); 110, maxilliped, ventro-outer (D); 111, leg 1 and intercoxal plate, anterior (F); 112, leg 5, dorsal (E); 113, spermatophore, attached to female, ventral (B).

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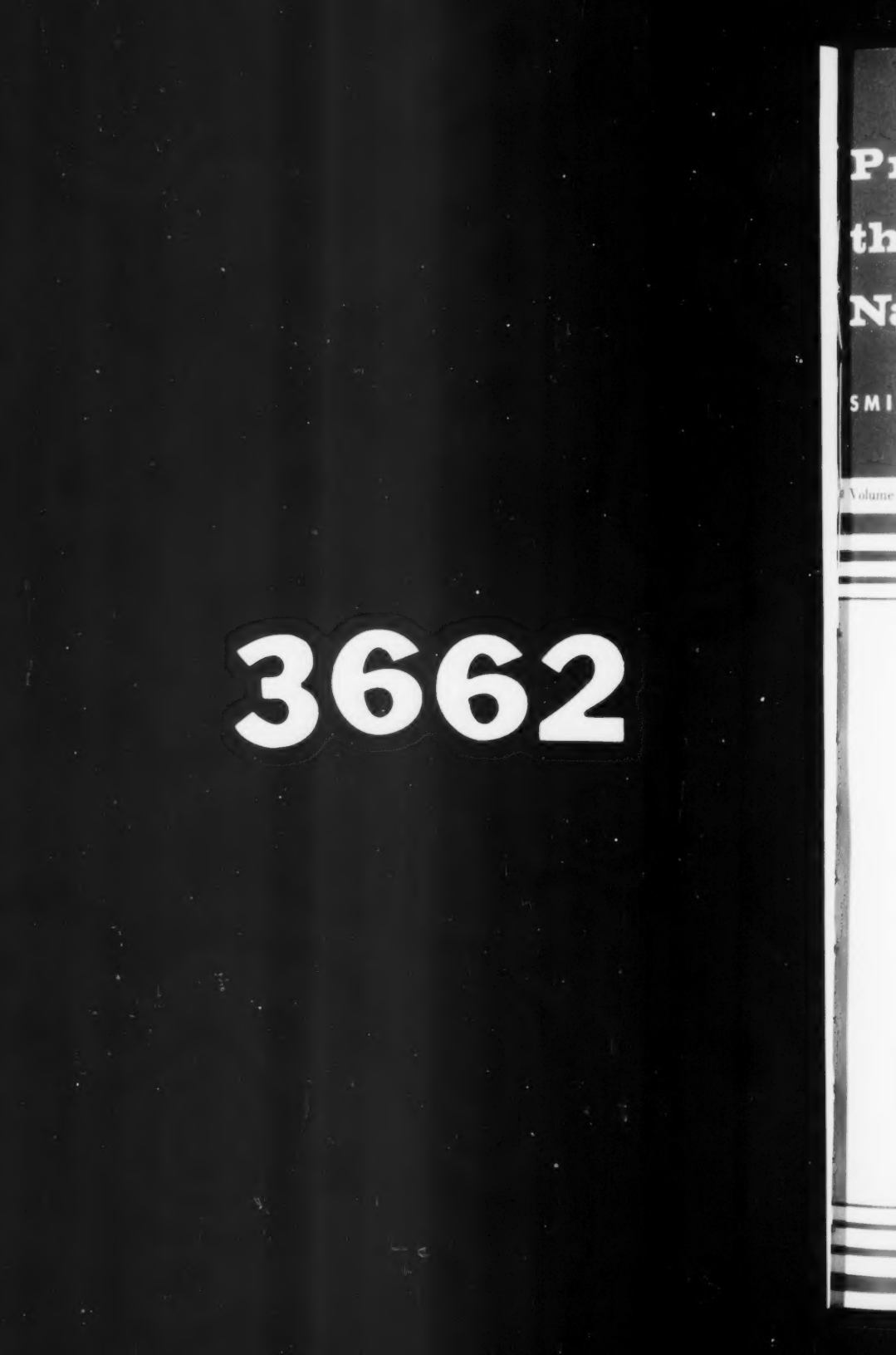
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Prospects in Primate Biology

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with preface by

S. Dillon Ripley

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Prospects in Primate Biology

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Director of Primate Biology Program

Preface

In recent years the great increase in studies in physical anthropology as well as the paleontology of the more recent periods of geologic time has focused scholarly attention on man's relative and potential ancestors to a new level of intensity. Partially, this has been the result of the effect of the evolutionary theories postulated since 1930 by Huxley, Dobzhansky, and others. As Mayr (1963, Animal species and evolution, p. 637) has stated:

> It was hopeless to try making sense of hominid phylogeny as long as the fossil remains of man's ancestors were considered anatomical "types." . . . The study of the geographic variation of animals and a new insight into the process of speciation have introduced into the study of fossil man new concepts [and]—a great simplification of the general picture.

An understanding of man's rapid mental evolution in the past million years, based presumably on the refinements of speech and tool making, has led biologists and anthropologists into a major field of study—the social organization and behavior of primates. Primate biology gives every indication of being one of the most vigorous and rewarding areas of research although still in its formative stages. One of the charming idiosyncracies of this field of study is that it is

interdisciplinary, that is, it is the proper concern of "so-called" biologists, "so-called" anthropologists, and "so-called" paleontologists. Such an unorthodox area for research can obviously best be performed in unorthodox places, perhaps one reason why Hooton's hope (cited by Napier) that primate biology would become established as a separate teaching division in universities has not been realized. Universities as a whole are largely losing their ability to be innovative, thus putting more pressure on smaller institutions like private laboratories or museums to maintain their fundamental reasons for being. I once characterized the Smithsonian Institution as populated by specialists who were inheritors of a tradition of the "unfashionable in pursuit of the unconventional." The urgent need for studies such as those outlined in this paper is underscored by Dr. Napier's concise account of the rapidly diminishing status of many of the primate species. Conservation is by no means a subject to be ignored by scientists. Environmental studies make conservationists out of the most realistic among us. Primate biology thus becomes one of the most urgent of all interdisciplinary concerns of science today.

S. Dillon Ripley
Secretary
Smithsonian Institution

Primate biology as a scientific endeavor is unique inasmuch as it provides a mirror into which man may look to discern the nature of his own species.

Nonhuman primates, occupying an intermediate position between other mammals and man, serve as a constant reminder of the continuity of mammalian life. Thomas Henry Huxley in 1876 expressed the essence of this special primate role:

> Perhaps no order of mammals presents us with so extraordinary a series of gradations as this—leading us insensibly from the crown and summit of the animal creation down to creatures from which there is but a step, as it seems, to the lowest, smallest and least intelligent of placental mammals.

The significance of this relationship between man and the nonhuman primates is—to translate and paraphrase the late Earnest Hooton's happy plagiarism of the poet Terence—that "anything to do with primates is something to do with man." It is inherently probable, therefore, that any basic concept developed in the fields of primate physiology, psychology, or therapeutics, for example, can be applied also to man. This tenet now widely appreciated provides the rationale for the extensive use of primates as experimental subjects in medical and sociological research.

Not so widely appreciated, however, is the urgency of providing rear-guard support for the flying columns of applied primate research.

Perhaps at this point it should be emphasized that there are two main types of primate research that, broadly speaking, can be classified as applied/project-oriented or academic/subject-oriented. Project-oriented research is research *with* primates using them as other laboratory animals are used in order to test the efficacy of a technique that cannot be so tested in man. Subject-oriented research is research *on* primates that leads to a further understanding of their biology and, by the nature of their relationship to man, to the development of hypotheses that can be tested subsequently in a human context. Subject-oriented research, thus, tends to produce results that are seldom of immediate applicability to areas of human health and welfare; they are usually at least one stage removed from medical or sociological usefulness.

The work of Landsteiner and Wiener on the *Rhesus-antigen*, which was later shown by Levine et al. (1941) to be identical with the blood-factor involved in cases of human erythroblastosis foetalis, provides a good example of the value of a "once-removed" type of applicability.

As an example of subject-oriented research, Haddow's (1952) field study on *Cercopithecus ascanius schmidti* may be recalled. This basic research project not only contributed to our knowledge of the ecology and behavior of the redtail guenon, but also it provided the essential background to Haddow's later work on the epidemiology of sylvan yellow fever. The work of Harlow and his associates (1958–1965), of Mason (1965), and of Hinde (1966, 1967) on the affectional systems of monkeys and apes already has had profound repercussions in the areas of child health and development and social psychology. In the field of sociology and social anthropology the zoological perspective (particularly in primate field studies) is leading already to a better understanding of human behavior and human social systems (Tiger and Fox, 1966; Morris, 1967). Subject-oriented research also is often anticipatory as discussed by Riopelle (in press), who recalls, inter alia, that W. S. Hunter developed the delayed-response test in 1913 long before it became useful as a means of measuring function in the frontal lobes in man.

Subject-oriented research requires not only a specific training in primatology (at least at graduate level) but a continuing exposure to an academic environment where peer-contact has the salutary effect of promoting self-criticism and of stimulating intradisciplinary, subject-oriented thinking. Project-oriented research, on the other hand, given good primatological advice at its inception, need not be done in a primate-oriented environment; it can be carried out wherever ap-

propriate laboratory facilities and experienced animal handlers are available.

It is easy to understand why, in a period of political or economic crisis with a premium on pragmatism, the "once-removed" aspect of subject-oriented research does not usually attract much in the way of sympathy or support. This attitude, however, is invoking expediency at the risk of self-immolation. It is precisely in such times that a long-term view is necessary. In a recent article, Leaf (1968) stated: "Emphasis only on applied research in medicine would quickly exhaust the present level of understanding and yield only inadequate solutions to major health problems." In particular reference to primate biology, the need for subject-oriented research is pressing, for seldom in the history of scientific endeavor has any new edifice been erected with so little regard for the nature of the bedrock. In a letter to "Science," Moor-Jankowski (1965) pointed out that the paucity of subject-oriented research in primatology has been due not so much to the lack of support (by funding agencies) as to the lack of competent scientists. This deficiency can be traced to the fact that university training for this fruitful field of research is virtually nonexistent.

The hope expressed by Hooton (1954) that primate biology would become established as a separate teaching division in the universities has not been realized. This is not to say that the subject is not being taught at all—far from it. Primatology always has constituted an important aspect of degree courses in anthropology and is taught in most university departments. Principally, however, the emphasis is placed on primate evolution—and a somewhat anthropocentric approach to evolution, at that. Only rarely, for example, are primate anatomy, genetics, behavior, and serology covered in any detail. Primate systematics and classification seldom, if ever, form a part of the curriculum. Perhaps the complete absence from scientific literature of a student textbook on primatology is the best pointer to the present deplorable state of affairs.

It would seem to be a matter of fundamental importance that in countries where primate research is active and ongoing that there should be centers where teaching and training programs in primatology can be carried out and where future staffing needs of research institutes and primate breeding centers can be catered to.

Considering the enormous national investment in primate research, it seems quixotic, to say the least, not to insure that centers of research are also centers of education. Basic research and education programs are inseparable. The establishment of graduate and undergraduate education programs will bring about a rapid accumulation of the baseline data so urgently needed by research scientists today.

It is not possible to anticipate in detail the direction that future research will take, but, without a shadow of doubt, it will become heavily committed in the areas of child development, and mental, social, and environmental health and behavior. In these fields the experimental animal must be a primate. Information, firmly rooted in biology, will be needed about the behavioral parameters of primates under varying conditions: firstly, in the field in the framework of ecology; and secondly, in artificial environments ranging from the near-normal conditions of the field-cage to the wholly artificial conditions of the laboratory. These studies of naturalistic and "semi-naturalistic" behavior are subject-oriented just as certainly as are the more traditional academic disciplines of anatomy, taxonomy, and phylogeny.

Primate Biology Today

The last ten years have seen the coming of age of two subjects concerned with the science of man—human biology and primate biology. Although they can scarcely be considered new disciplines, they reflect a new attitude of mind and provide fresh ways of looking at old problems.

The approach to both is naturalistic. The animal, whether man or nonhuman primate, is studied primarily as a living creature in the context of its normal environment; it is regarded as a member of a natural population, not as an individual; and it is regarded as an expression of the phenotypic variation of the species rather than as the archetype of the race. These principles require new and liberal perspectives in study methods. Human walking, for instance, one of the more simple components of human behavior, cannot be investigated merely by studying the osteology of the limbs, nor can it be explained solely in terms of the biomechanical functions of the relevant muscle groups. Walking also is concerned with the environment of men who walk and with their physiological needs in a variety of different habitats; it is concerned with the effects of culture on the periodicity of this human activity and the historical conditions that led to its evolution.

To study primate behavior entails a consideration of anatomy, physiology, biochemistry, ecology, ergonomics, paleontology, anthropology, and genetics. With a multidisciplinary approach of this sort, primate biologists cannot afford to be specialists. While inevitably possessing special knowledge in particular fields, they require a general awareness of all relevant fields. In this context "awareness" can be interpreted as an attitude of mind that, in turn, can only evolve from a training that is designed to develop it. There is much to

be said for the training of the specialist with his rigorously channelled expertise, providing that his future employment asks no more of him than this; but there is a real place in twentieth-century science for the multidisciplinary scientist.

The interrelationship of primate and human biology is intricate and important both pragmatically and philosophically. They stand in much the same relationship, for example, as political economy and political history, as mining engineering and petrology, as sociology and social anthropology. The first of each pair is concerned primarily with the present, and the second is involved principally with the past. Primate biology, though not a historical subject per se, stands in historical relationship to human biology. Man is a recent innovation of primate phylogeny with a relatively brief history as *man* but an extremely ancient one as a *primate*. Chimpanzees and gorillas are the living descendants of the same group from which man's remote ancestors were drawn millions of years ago. In this regard they serve as genetic models for man. Their value for biomedical research depends on this close blood relationship. Other primates—the baboons, for instance, which, like man, are recent innovations—are too phylogenetically remote to serve as genetic models. Baboons and macaques occupy a broadly similar ecological niche today as the primate precursors of man occupied some fifteen million years ago. The study of these animals, which can be regarded as ecological models, might, therefore, be expected to provide valuable clues for the development of hypotheses concerning the roots of the human social organization. It is no coincidence that baboons, macaques, and chimpanzees are the most widely used of all nonhuman primates in biomedical and sociological research.

The past of organisms is one of the determinants of their future, and the most fruitful place to look for man's past is not only in ancient and inaccessible rocks but also in the structure and behavior of living primates.

At Oxford, England, in 1864 Disraeli said: "The question is this: is man an ape or an angel? My Lord, I am on the side of the angels." A hundred years later we are no longer interested in the answer to Disraeli's rhetorical question. We do not regard it as being particularly important. Man and apes are part of one zoological order, the Primates, an order that also includes the monkeys and the lemurs, and the close relationship of these forms to man is no longer a matter of dispute or concern. The essential conformity of man and the primates in morphology, physiology, serology, and behavior is beyond question, and the problem now facing primate biologists is the clarification of the relationships within the order, with extension of knowledge in depth and breadth to include as much information on struc-

ture, genetics, behavior, and ecology for as many different species of primates as possible.

Professor Sir Wilfrid Le Gros Clark in an address to anthropologists in 1959 discussed the evolution of a new discipline. He observed that all branches of science in their neonatal stages passed through a collecting and cataloging phase. As far as primate biology is concerned, these preliminaries must be regarded as an essential stock-taking exercise during which the language and methodology of the subject must develop and the basic facts of primate biology are collected, synthesized, and disseminated. Primate biology is still, strictly speaking, in this phase. We still need to find out what it is all about, what we know, what we don't know, what is relevant, and what is totally irrelevant. Primate biology needs a plan, a blueprint from which to build a significant and durable structure.

Diminishing Primate Stocks

High on the priorities list of a primate research program should be studies directed toward the understanding of the *captive* primate. Before the end of this century there will be only a few natural populations of primates, living undisturbed lives, left in Africa, Asia, or Latin America. The majority of nonhuman primates will be captive in one sense or another. They may be under close restraint in medical laboratories, in zoos, in breeding ranches in the tropics, in free-ranging colonies in temperate zones, on isolated islands, or in reservations and game parks, but captive, nevertheless. This gloomy prognosis is the inevitable result of extrapolation from three unrelated trends: firstly, the ever increasing deforestation that results from agricultural development in tropical countries; secondly, the widespread native habit of killing monkeys for food, particularly in West Africa, where they constitute a vital source of animal protein; and thirdly, the exorbitant rate of consumption of primates by research scientists. Importation of monkeys into the United States during F.Y. 1966 has been estimated to have exceeded 100,000 individuals; the vast majority, it can be assumed, ended up in biomedical research laboratories. This rate of consumption could lead rapidly to extinction of certain populations in the wild: monkeys simply do not breed at this rate. Rhesus monkeys and the common langur (*Presbytis entellus*) already are showing signs of depletion in certain regions of Asia. Southwick, Beg, and Siddiqi (1961), who carried out a population study of rhesus monkeys in 1959–1960 in the Uttar Pradesh province of India, observed a marked shortage of juveniles in many troops.

The golden tamarin (*Leontideus rosalia*) is said to be near extinction in Brazil although the blame in this instance cannot be laid at the

door of the scientist. In Sierra Leone it has been estimated that, for every young chimpanzee exported for research or for zoos, between four and six mothers have to be killed. Since each of these mothers might be expected to produce up to ten offspring in a lifetime, the potential loss to the wild population for *every* young chimpanzee captured is between forty and sixty individuals. Estimations of this sort can never be particularly reliable, but even the loss of a single breeding female for every infant captured could eventually have a severe effect on population numbers.

There are clearly several ways of approaching the problem of diminishing primate stocks. Firstly, there is the matter of conservation. This is an admirable concept, and, indeed, conservationists can chalk up a number of important successes for which the whole world should be grateful, but unless the aims of conservation are anticipatory rather than retrospective, the problem of the primates will not be solved by such measures. The only possible procedure for the orangutans of Borneo (it seems inevitable that the Sumatran race is past saving) is to establish protected colonies on suitable islands. The real problem for the future are monkeys such as the patas, the vervet, the baboon, and the macaque, all of which, though plentiful now, may not always remain so. On the basis of present trends, it is difficult to see how natural populations of these animals can survive beyond the end of the century. It is the *potentially* vanishing species that should be the principal targets of conservationists, not populations that are already doomed.

Information is urgently needed on the population numbers of free-ranging primates, particularly the most popular laboratory animals, in order to guide future policies on importation of primates and the establishment of breeding colonies at home. We have little or no precise knowledge of current wild population numbers or of population dynamics in the countries of origin of these animals. Rumors abound, but factual information is lacking.

Choice of Primates in Medical Research

Although the literature in recent years on the care of primates in medical research laboratories has grown astronomically, relatively little consideration has been given to the selection of primates specifically appropriate to particular types of research investigations.

The choice of a nonhuman primate is largely a hit-or-miss affair and will continue to be so until the biological properties of all species have been fully investigated. Reference to recent publications (e.g., Montagna, 1967), to the symposium volumes edited by Vagtborg (1965) and Fiennes (1966), respectively, and to the textbooks of

Ruch (1959) and Fiennes (1967) would reveal a great deal of information on the proved and potential usefulness of particular species for particular problems. A comprehensive account of the research potential of the 197 species of primates is beyond the scope of the present article.

Choice of a suitable primate for a specific project, therefore, must depend on hearsay, on the published reports of other workers, or, in the last instance, on trial and error. Finally, selection will be influenced by pragmatic considerations that relate to available space, available resources, and available primate species. There are no hard and fast principles by which suitable animals may be selected except that of phylogeny, which, at best, can act only as a general guide.

The phylogenetic article of faith is simply stated: The experimental results that are most likely to be meaningful in a human context are those carried out on animals that have the closest genetic relationship (and, therefore, phylogenetic proximity) to man.

The phylogeny of the primates is shown diagramatically in figure 1, wherein primate families and their component genera have been arranged in terms of their relative closeness to man.

PROSIMIANS.—The Prosimians comprise six families, which are arranged as follows: Tupaiidae, Lorisidae, Daubentoniidae, Indriidae, Lemuridae, and Tarsiidae (Napier and Napier, 1967). The use of prosimians as laboratory animals has been discussed recently by Manley (1967), Montagna (1967), and Hill (in press).

Treeshrews (Tupaiidae) are not unequivocally primates. Opinions differ strongly at the present time as to whether they should be so regarded. The attitude taken by the author is that, whether technically they are primates or not, they are thought to be so close to the phyletic root of the order (at a time when all primates were insectivores, so to speak) that they should be retained in the Primates, if only as a permanent reminder of the generalized mammalian origins of the stock. Treeshrews have not been used widely as laboratory animals except in strictly physiological experiments, but with the new information emerging on breeding behavior (Martin, 1966), they may well attract more attention.

Among the Lorisidae, galagos are potentially the most useful. Their relatively short gestation period (*Galago crassicaudatus:* 130–135 days; *G. senegalensis:* 144–146 days) and the not uncommon occurrence of twin births mark them as possibles. A number of primate centers and research laboratories are breeding these animals successfully. The melanistic race, *G. c. argentatus*, is tougher and heavier than the brownish *G. c. crassicaudatus* and may prove to be more hardy in captivity; it is possible that it may be a good subject for an open-air colony situation.

The Lemuridae are the only other family of the Prosimian radiation that are likely to be available for laboratory work; the remaining families are too rare and too delicate to be considered. Lemurs, specially the robust ring-tail (*L. catta*), have been bred successfully

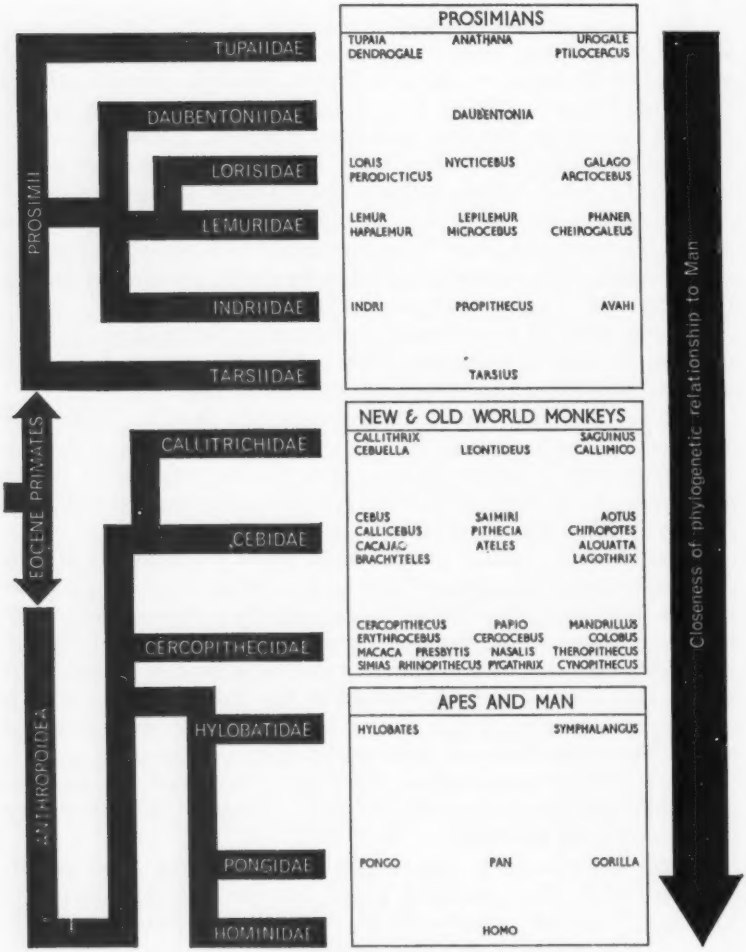


FIGURE 1

in quite large numbers in laboratories and zoos in recent years as also, to a lesser extent, have the black lemur (*L. macaco*) and the brown lemur (*L. fulvus*); however, it is certain that scientists who have a special reason for employing these animals in research will have to

depend wholly on their own breeding stocks in the future as all Madagascan prosimians are rigorously protected. The value of prosimians as laboratory animals is largely unknown, but, generally speaking, their usefulness lies in the field of basic research. This is exemplified by the ongoing studies of Montagna and his colleagues on cutaneous anatomy and physiology. As substitutes for higher primates in the fields of cancer research, immunology, and pharmaceutics, they leave much to be desired.

NEW WORLD MONKEYS.—The New World monkeys comprise two families, the Callitrichidae [1] and the Cebidae. Marmosets (*Callithrix*) and tamarins (*Saguinus*) have enjoyed—if that is the right word—a high popularity during the last five years. Their principal advantage is their small size and the free availability, in particular, of *Saguinus*. The common marmoset (*C. jacchus*) is becoming increasingly rare according to certain authorities (Hill, in press).

A discussion of the suitability, disease hazards, and basic biological data of marmosets and tamarins has been summarized by Deinhardt and Deinhardt (1966); breeding of marmosets in captivity has been discussed by Hampton et al. (1966).

Although phylogenetically the most remote from man of all higher primates—and, therefore, of limited value in procedures that hinge on close genetic proximity to man—marmosets are most useful animals in certain specific research projects. In the study of viral hepatitis, for example, they appear superior to other nonhuman primates, always excepting the expensive chimpanzee (Deinhardt and Deinhardt, 1966).

Among the Cebidae, the only species that merit consideration at the moment are the squirrel monkeys, the douroucoulis or night monkeys, and the capuchins. The shortness of this list reflects as much as anything the neglect of the New World genera by primate biologists. No doubt this neglect can be traced to the remoteness of this group from the story of human evolution, which in the past constituted the principal raison d'être for studying primatology.

Cebus, the capuchin, which is said to be resistant to tuberculosis, has been discussed by Stare et al. (1963), principally in relation to dietary factors in the etiology of atherosclerosis. Squirrel monkeys, which fulfill nearly all the criteria for the ideal laboratory animal except that of phyletic proximity, are widely used in neuroanatomical studies in arteriosclerosis research and in space physiology. One of the most surprising animals to emerge as a promising laboratory species

[1] The spelling of Callitrichidae is that originally used by Thomas (1903). The termination appears to be formed in accordance with Appendix D, Table 2, of the "International Code of Zoological Nomenclature" (1964), and, therefore, there is no case for amending Thomas' spelling.

is *Aotus* (the douroucouli), the only nocturnal higher primate and one of the most primitive monkeys in existence.

OLD WORLD MONKEYS.—The Old World monkeys comprise the single family Cercopithecidae; of the two subfamilies, the Colobinae and the Cercopithercinae, only the last named are presently of interest to the research scientist. The contribution of the Cercopithecinae to human research has been discussed by Jolly (1966).

Macaca mulatta, the rhesus monkey, the "monkey" of medical literature, is too well known to merit discussion here; its use in the identification of the Rh blood factor and in the development of poliomyelitis vaccine is common knowledge. The breeding record of the rhesus macaque, its toughness, availability, and cheapness make it the best all-round research animal. Certain other macaque species as the crab-eater, the pig-tail, the stump-tail, the bonnet, and the Japanese macaque all breed well in captivity. The last mentioned promises to be especially valuable as a species that can be bred freely in open-air compounds, even in high latitudes.

The closely related Celebes black "ape" (*Cynopithecus niger*) is another primate that seems to breed well in captivity. As a bonus, Celebes apes are, for Old World primates, quite friendly animals. One might guess that imported stocks of *Cynopithecus* are never likely to be adequate for extensive research usage due to the restricted range of the species. Their future usefulness will have to depend largely on domestic breeding programs.

Baboons have grown in popularity in recent years and are becoming biologically very well documented (Vagtborg, 1965). They are of particular value in surgical procedures (Moor-Jankowski, 1967). Baboons have been used extensively in studying the etiology of atherosclerosis and other cardiovascular diseases of man at Sukhumi in the U.S.S.R., for instance, and at the Southwest Foundation, San Antonio, Texas.

The leaf-eating section of the Cercopithecidae, the Colobinae of southeast Asia (*Presbytis*, *Nasalis*, etc.) and Africa (*Colobus*) are so specialized in their diet and, relatively speaking, so little known biologically that they have no place in medical laboratories at the present time. A possible exception to this generalization is the Hanuman or entellus langur (*P. entellus*), which is hardier than most other species and more ground adapted (Jay, 1965).

The remaining Old World monkeys to which reference should be made have been grouped by some taxonomists (Jolly, 1965) into a tribe, the Cercopithecini, that includes the following genera and subgenera: *Cercopithecus*, *Cercopithecus* (*Miopithecus*), *Cercopithecus* (*Allenopithecus*), and *Erythrocebus*. This tribe is not generally regarded as important in biomedical research, but there are at least three

species that are worthy of note—the talapoin, the savannah monkey,[2] and the patas. The talapoin is untried as a laboratory animal but is theoretically desirable in view of its small size and the possession of a sexual swelling in females. Savannah monkeys have been used fairly extensively, notably in the culture of poliomyelitis vaccine. Patas monkeys are used quite widely in Britain today; the fully adult male patas monkey, however, equals a male baboon in size.

Some slight success in breeding talapoins in the laboratory has been reported (Hill, 1967). There is little information on breeding of patas monkeys beyond the fact that between 1959 and 1963 twenty-four births were recorded in world zoos (Napier and Napier, 1967). Goswell and Gartlan (1965) have recorded a single instance of a laboratory birth. Savannah monkeys and their allies, on the other hand, breed moderately freely. It seems logical to anticipate that other members of the genus *Cercopithecus*, such as *C. ascanius schmidti* (the red tail), would be of value in research once they are better known biologically.

Apes.—It is hardly necessary to discuss the apes in the context of human research. While it is obviously highly desirable on phylogenetic grounds that chimpanzees should be used for many aspects of biomedical research, their expensiveness and relative rarity should preclude their use other than in very exceptional circumstances wherein no alternatives exist. This does not prevent chimpanzees from being employed in experimental work that does not result in the sacrifice of the animal. It is perhaps in the fields of functional morphology and growth and aging studies that these animals can contribute most to human understanding.

Gorillas and orangutans have no place in the medical laboratory owing to their extreme rarity although, as in the case of chimpanzees, they can contribute to many aspects of human biology. The only remaining ape species to be considered is the gibbon. Being the most active of all primates, they require considerable space in order to remain healthy through the performance of a normal locomotor repertoire. Their unique—in an Old World primate sense—social behavior patterns make them unsuitable as breeding animals.

The scientist faced with a research problem must choose the animal most suited to his requirements. Perhaps the most serious question that he must ask himself is: Need primates be used at all for this particular experiment? Would not a white rat, a guinea pig, or a rabbit do just as well? The conservation of wildlife is a serious scientific, economic, and social problem and not simply a hobby for elderly ladies. Primates are rare animals, and it should be a matter for pro-

[2] Common names of the three geographical species of the savannah monkey (*C. aethiops* group) are the grivet, the vervet, and the green monkey.

found thought before the decision is made to remove an animal from the wild. Medically useful primates must be bred in captivity in sufficient numbers so that the cause of scientific conservation is not imperilled by the extravagant demands of a sister science.

Primate Biology at the Smithsonian

This recently inaugurated primatology program has a single, clear purpose: To foster the development of primate biology as a scientific endeavor on an international scale. It is to be hoped that this new program will play a central and a catalytic role in the rapidly expanding field of primatology by encouraging basic research, particularly in systematics, and promoting educational programs in the universities, particularly those closely associated with centers of primate research.

The Primate Biology Program is planned as an international facility having, in the first instance, two offices, one in Washington, D.C., at the Smithsonian Institution, and one, in London, England, with close affiliations to the University of London. For geographical and other practical reasons it is likely that the program emphasis will differ somewhat between the two centers; for instance, the magnificent collections, the preparation and storage facilities of the U.S. National Museum, and the proximity of other major museum collections would favor Washington as the locus of systematics research. On the other hand, the close association of the London office with the University of London will facilitate the development of this center as a locus of undergraduate teaching. Graduate training programs would be located in both centers; however, it is not envisaged that the various projects will be divided between the two centers so much as shared between them. Each will contribute to the total program as its native talents and material resources dictate. A regular exchange of students and professional staff between London and Washington will do much to foster the principle of unity.

The following section constitutes a working plan that embodies a research and education program of considerable magnitude and breadth. It is not anticipated that all the projects will develop simultaneously; indeed, it may be several years before some of them can be initiated.

Research Program

Certain aspects of primate biology such as systematics and nomenclature, anatomy and physiology, evolution, zoogeography and population dynamics, free-ranging behavior and ecology, and base-line data on the ecology of captivity are in urgent need of development. These problems are the basic requirements of research workers who, in the design stage of their experiments, must ask themselves a series

of questions (the particular fields of study that might be expected to supply the answer are shown in parenthesis):

Q. 1. Which is the most suitable primate for my purpose? (Anatomy, physiology, psychology. Evolution. Systematics and nomenclature.)

Q. 2. Where can I obtain a regular supply of this species? (Zoogeography. Population dynamics.)

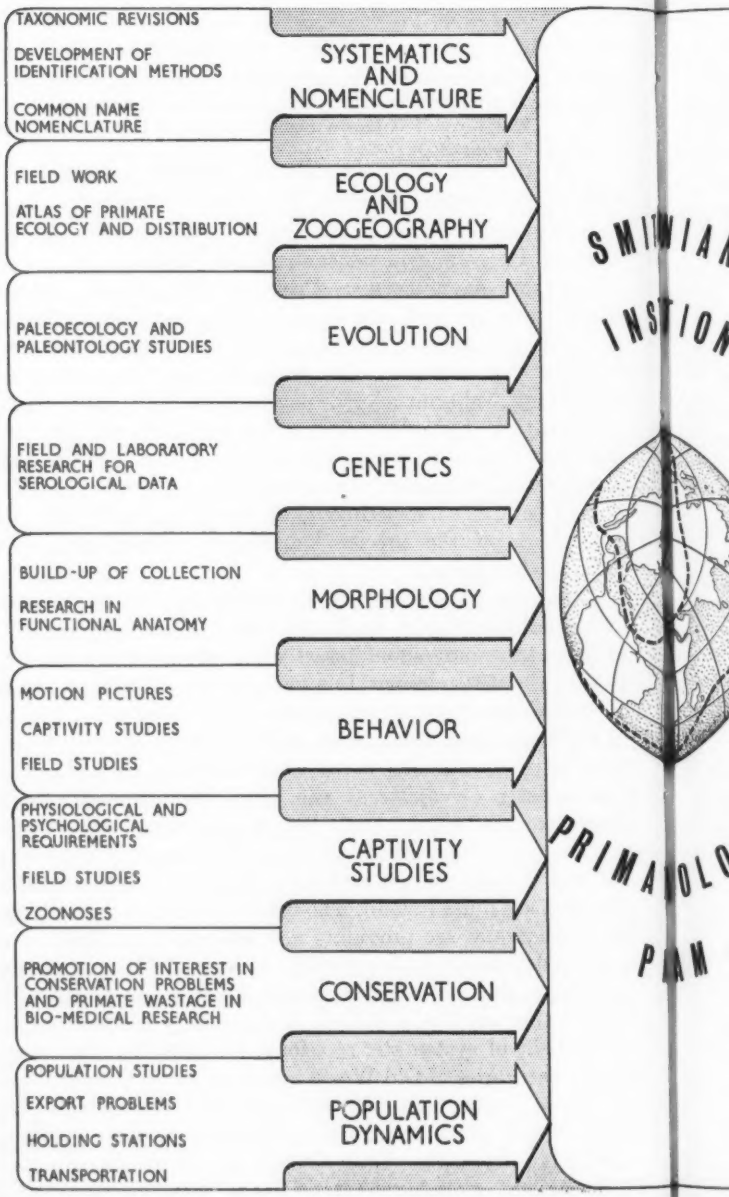
Q. 3. How can I best maintain these animals in captivity? (Free-ranging behavior and ecology. Base-line data on captivity ecology.)

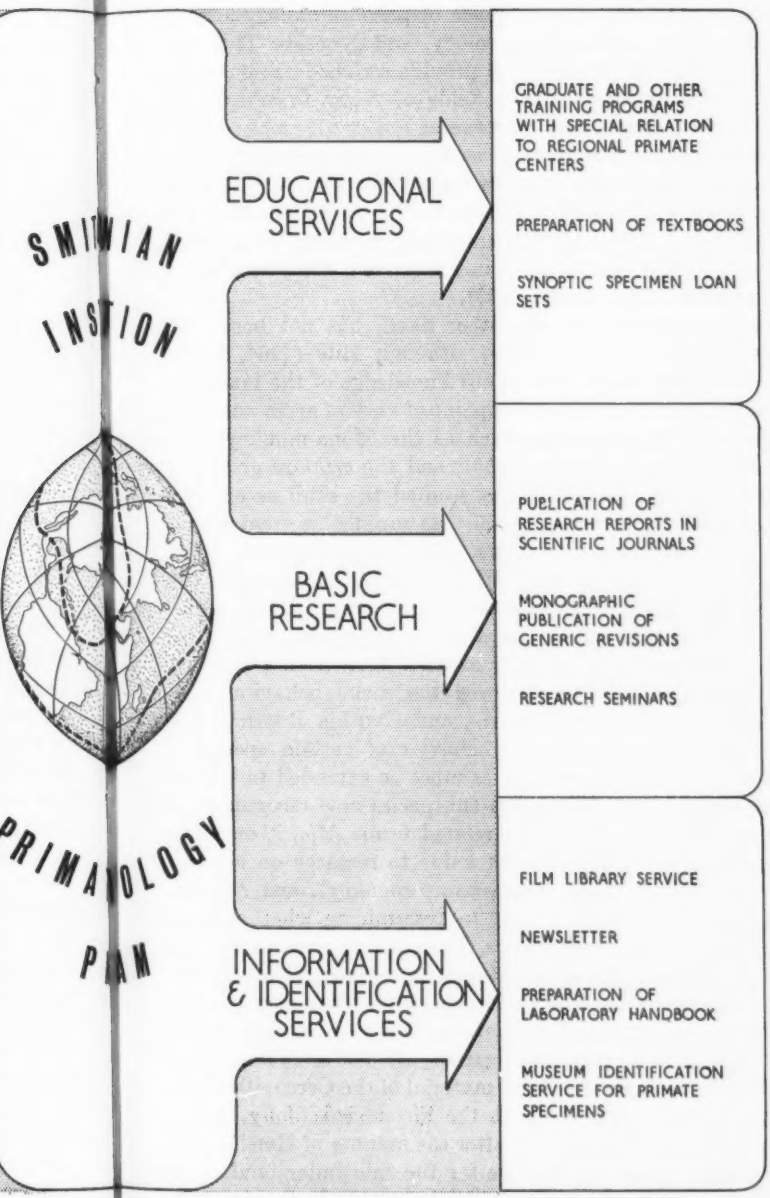
It is in such fields of inquiry as these that the Smithsonian Primate Biology Program will concentrate its efforts.

PRIMATE SYSTEMATICS.—Problems in primate systematics are many and great and constitute a major handicap in the rapid development of research programs employing nonhuman primates as experimental animals. The interpretation of results in fields of physiology, pharmacology, psychopathology and neuropsychiatry, comparative psychology and ethology often depends on a precise knowledge of the systematic status of the subject animal. With imperfect identification, the contributions of previous research workers cannot be utilized, experiments cannot be repeated, and hypotheses—dependent on the precise knowledge of relationships—cannot be developed or tested.

A revision of primate systematics is long overdue for many groups and should rank high in the priorities of any program. Research in primate taxonomy should start with revision of genera. It is difficult to talk about species within a genus without knowing the exact limits of variations among genera themselves. Genera in most urgent need of revision, other than those already being examined, are found in most of the prosimians, many of the Cebidae, certain Cercopithecidae (particularly *Cercopithecus* and *Cercocebus*), and all the Colobinae. Only after restudying such genera can classifications be revised in a meaningful way. Many of these lists are half a century or more old and include species and subspecies that, in the light of modern theories, are quite invalid. The use of computers and advanced statistical techniques are providing new and more accurate means of zoological classification. A recently (Groves, 1967) completed study of gorilla populations using these techniques is an example of the sort of results that can be obtained. Evolutionary studies are a necessary component of systematic revisions; for example, the arrangement of higher categories of Old World monkeys depends on understanding of the phylogenetic relationships among the *Macaca-Papio* ground-living group of Old World monkeys, the arboreal colobine monkeys, and the curiously intermediate *Cercopithecus* and *Cercocebus* groups.

Inasmuch as modern systematics is based on the total biology of populations, a program of revision must be broadly based and must


TAXONOMIC REVISIONS
DEVELOPMENT OF IDENTIFICATION METHODS
COMMON NAME NOMENCLATURE
SYSTEMATICS AND NOMENCLATURE
FIELD WORK
ATLAS OF PRIMATE ECOLOGY AND DISTRIBUTION
ECOLOGY AND ZOOGEOGRAPHY
PALEOECOLOGY AND PALEONTOLOGY STUDIES
EVOLUTION
FIELD AND LABORATORY RESEARCH FOR SEROLOGICAL DATA
GENETICS
BUILD-UP OF COLLECTION
RESEARCH IN FUNCTIONAL ANATOMY
MORPHOLOGY
MOTION PICTURES
CAPTIVITY STUDIES
FIELD STUDIES
BEHAVIOR
PHYSIOLOGICAL AND PSYCHOLOGICAL REQUIREMENTS
FIELD STUDIES
ZOONOSES
CAPTIVITY STUDIES
PROMOTION OF INTEREST IN CONSERVATION PROBLEMS AND PRIMATE WASTAGE IN BIO-MEDICAL RESEARCH
CONSERVATION
POPULATION STUDIES
EXPORT PROBLEMS
HOLDING STATIONS
TRANSPORTATION
POPULATION DYNAMICS


SMITHSONIAN INSTITUTION
PRIMATOLOGY PROGRAM
EDUCATIONAL SERVICES
BASIC RESEARCH
INFORMATION & IDENTIFICATION SERVICES
GRADUATE AND OTHER TRAINING PROGRAMS WITH SPECIAL RELATION TO REGIONAL PRIMATE CENTERS
PREPARATION OF TEXTBOOKS
SYNOPTIC SPECIMEN LOAN SETS
PUBLICATION OF RESEARCH REPORTS IN SCIENTIFIC JOURNALS
MONOGRAPHIC PUBLICATION OF GENERIC REVISIONS
RESEARCH SEMINARS
FILM LIBRARY SERVICE
NEWSLETTER
PREPARATION OF LABORATORY HANDBOOK
MUSEUM IDENTIFICATION SERVICE FOR PRIMATE SPECIMENS

involve research into many diverse fields of primate biology such as anatomy, paleontology, behavior, serology, and genetics. Thus, the systematics program undoubtedly will provide a considerable mass of fall-out information in these special fields of study in addition to providing taxonomic revisions of the genera.

Priority from the point of view of early revision will be given to those genera most commonly used in scientific research. The marmosets are undergoing revision at present (Hershkovitz, 1966, and in litt.) as are some of the macaque species (Fooden, 1964, 1967). *Papio* recently has been restudied, principally from the viewpoint of osteology and paleontology (Jolly, 1965).

The genus *Cercopithecus*, on the other hand, has not been fully revised since Schwarz' (1928) study, although Hill (1964, 1966a, 1966b) has contributed much toward our knowledge of the taxonomy of these animals, particularly from the point of view of gross anatomy. Certain species and species-groups such as the Mona monkeys have been reviewed recently by Booth (1955); and the *aethiops* group, by Dandelot (1959). Verheyen (1962) has studied the skull osteometrically and osteologically; Chiarelli (1966) has supplied a great deal of information on chromosome numbers. Jacob and Tappen (1957, 1958) have studied haemoglobins. Booth (1956, etc.) has studied the ecology of certain West African representatives, and Haddow (1952) has supplied detailed information for a single subspecies, the redtail (*C. ascanius schmidti*). Few behavior studies have been published; Hall and Gartlan (1965) have observed the social behavior of *C. aethiops* on Lolui Island, Lake Victoria, and Cynthia Booth (1962) and Brain (1965) have studied the behavior of certain species of *Cercopithecus* in captivity. These studies must be extended to include all twenty-one species and sixty-seven subspecies now recognized. It must also be extended to the closely related forms *Miopithecus* (the talapoin, a species potentially of great value to research on account of its small size), *Allenopithecus* (the swamp monkey), and *Erythrocebus* (the patas monkey) with a view to determining whether these forms are congeneric with *Cercopithecus*. The *aethiops* species-group of *Cercopithecus* are another potentially important source of laboratory primates. The aspects of the biology of this group needing particular study are serology, ecology, and behavior. Evolutionary studies, which should provide the basis of any classification, are also most important (see Jolly, 1966); fortunately, the fossil material of the Cercopithecidae is moderately common, particularly in the Pleistocene (Jolly, 1965). A zoogeographical study of the group after the manner of Hershkovitz on *Callicebus* (1963) is also imperative for the full understanding of their origin and dispersal (see also Tappen, 1960). It is proposed, therefore, to initiate a revision of the genus *Cercopithecus*. Other

genera to be studied early in the program will include *Saimiri* (the squirrel monkeys) and *Presbytis* (the langurs).

Taxonomic Teams: Revisions of the systematics of any group cannot, and should not, be carried out by any one individual. Essentially, these are team projects that should reflect the multidisciplinary approach of primate biology. For the proposed fundamental revision of the genus *Cercopithecus*, a team consisting of specialists in the following fields will be co-opted and will operate under the general direction of the author:

1. Osteometric and osteological studies.
2. Serology.
3. Locomotor adaptations.
4. External characters.
5. Ecology.
6. Behavior.
7. Evolution and zoogeography.

Other scientists will be co-opted on an ad hoc basis to study various special aspects of the program, i.e., parasitology.

Duration of Project: In view of the proposed depth and breadth of the revision of *Cercopithecus*, it seems likely that the project will last at least three years, possibly four or even five. Since the systematics team will be drawn from suitably experienced scientists working in different parts of the world, it is considered essential that they should be in constant communication in order that the products of their different viewpoints can be closely coordinated. As far as is possible, a new systematics project involving a separate team will be initiated every second year. Thus, at the end of a five-year period the revision of three important primate genera will be underway.

Study Conferences: The majority of the scientists comprising a "taxonomy team" will be employed on a consultant basis. In order to facilitate close coordination on the project, annual study conferences will be held to bring together the scientists concerned either in Washington or in London.

Publication: During the course of the project, publication of the results of individual studies will be encouraged. At the conclusion of the project, the revision will be published as part of a monograph on the biology of the *Cercopithecus* group.

NOMENCLATURE.—Revision is needed also in primate nomenclature. As more and more medical research laboratories utilize primates, the more urgent becomes the problem. The present nomenclature of primates is neither adequate nor sufficiently stabilized for scientists to communicate with one another without considerable danger of misunderstanding. The common laboratory primate, the crab-eating macaque, is a classic inmate of the nomenclatorial madhouse. It is widely and incorrectly known as *Cynomolgus* and less widely, and cor-

rectly, known as *Macaca fascicularis*, although most current systematic lists refer to it as *Macaca irus*. It is understandable that harassed research workers should throw up their hands at such an impossible situation and end by using its unequivocal common name, the crab-eating monkey. The stability-loving primate biologist asks nothing more than that he should be able to retire at night with a name on his lips that is still valid when he wakes up in the morning.

A Study Group for Primate Nomenclature and Systematics Research will be established at the Smithsonian under the aegis of the Primate Biology Program. Its purposes will be twofold: immediate and long-term. The immediate aim will be to prepare, in the light of present knowledge, the best possible working list of primate species for use in the Primate Centers and other research laboratories; its long-term function will be to determine the areas of primate biology where systematics research is most urgently needed, to foster such research, and to revise critically the nomenclatorial list from time to time as new, irrefutable evidence becomes available. In this way it is to be hoped that primate nomenclature will achieve a *uniformity* in primate research that it has never before enjoyed. Total *stability* of nomenclature is something that cannot be guaranteed; to advocate such a procedure would be to deny the ebb and flow of scientific opinion. Stability, nevertheless, will be the watchword of the Study Group and purely technical name changes will be examined very critically before the status quo of the working list is disturbed.

LABORATORY IDENTIFICATION.—The identification of animals at specific and subspecific level is a fundamental need in both the research laboratory and in the museum. The simplest method is by means of external characters. In the event, considerable reliance is placed on coat coloration. The only means by which this can be achieved other than by direct comparison with known specimens is by reference to published descriptions. Many of the current descriptions antedate the introduction of the Ridgway color system and are, therefore, unstandardized. The earlier Munsel system has been little used in mammalian identification. Even post-Ridgway descriptions with their innumerable subtypes (1115 in all) of the named colors of the spectrum are so complex as to be almost useless in practice for the taxonomist and nontaxonomist alike. At best, all qualitative systems are subjective.

It is proposed to investigate the feasibility of developing a quantitative method of determination of coat colors using the technique of "reflectance spectrophotometry" (Dice, 1947; Hill, 1960). There are a number of techniques available for color specification: the spectrophotometric curve, the tricolor reflectance value, and the C.I.E.

(Commission Internationale de L'Eclairage) system, which provides evidence of the dominant wave length of samples.

A pilot study of *Saimiri* is already underway. Hopefully, this technique will provide a method that can be used by nonprimatologists and primatologists alike to aid in the identification of the species under investigation.

POPULATION DYNAMICS.—Information is urgently needed on the population numbers of free-ranging primates, particularly the most popular laboratory species, in order to guide future policies on importation of primates and the establishment of breeding colonies in temperate climates. We have little or no precise knowledge of current wild population numbers or of population dynamics in the countries of origin of these animals.

Primate population studies should provide information on population levels, population trends, export problems, holding stations, transport mortality, as well as local attitudes and customs involving primates that might affect exportation.

This is a major project and will need to be developed in two phases: (1) The basic background knowledge of the distribution, abundance, and population dynamics will be gleaned from what is already published in the literature on primates. Much of it is archaic and imprecise, but, nevertheless, there is much that is of value that should be collated as a first step. It will be possible to extract much information on distribution, less on abundance, and very little on population dynamics. (2) Following library research, there should be corollary field studies of several of the important species. Primary emphasis would be on the definition of ecological factors most critical in limiting population growth and those factors favoring population expansion and maintenance. Means of carrying out censuses of populations in various situations would be sought. Finally, model studies of the population dynamics of one or two important species should be undertaken.

Much of the field work in the preliminary stages could be carried out in certain of the soft-currency countries under the Smithsonian's Foreign Currency Grant Program.

STUDIES OF THE HUSBANDRY AND WELFARE OF CAPTIVE PRIMATES.—One approach to the problem of diminishing stocks discussed above is obviously the increase of breeding and holding programs in artificial environments. Much more basic research is required before such programs can supply all the animals of different species that scientists require. One must know, for example, the normal diet of the primates concerned, as well as its seasonal variations, and the typical locomotor habits and resting postures of the primates in order that appropriate

cages, enclosures, holding chairs, etc., can be designed. One must understand the social composition of the species concerned; each species has its own pattern of social behavior that must be understood if the animals are to be kept in captivity as healthy breeding units. One must know the technical details of the microclimate, the temperature-ranges, and the humidity. One must know the physical nature of the environment: Do these monkeys live among the small flexible branches of the canopy, on the stout branches near the trunk, or on the trunk itself? Only by finding the answers to these questions can one hope to provide, artificially, something approaching a realistic (though obviously not a normal) environment for the animal concerned. To provide a captive animal with an adequate, suitable environment is not only humane but sound common sense. Many of these problems are now being tackled in the Regional Primate Centers in the United States, but the basic research necessary for a full awareness of the welfare and husbandry of a wide range of primates will take many years of detailed and imaginative research.

Boredom in captive primates is another very serious, but generally unappreciated, problem. In the wild, most of the primate's working hours are spent in search of food. If, in captivity, it is deprived of this occupation, it has no normal substitutes. It develops behavioral aberrations such as coprophagy, masturbation, and stereotyped behavior patterns like staring into space for long periods, clasping the head or body and rocking to and fro, and hopping from one foot to another. These are typical withdrawal patterns seen in deprived primates, human or nonhuman. It has been said that "a solitary chimpanzee is no chimpanzee at all." Much of the boredom can be alleviated by caging monkeys in social groups so that normal social interactions, such as grooming activities among adults and play among infants and juveniles, can help to compensate for the lack of active food-getting. Ideally, some type of food-getting activity should be devised; for example, it should be possible to mix food pellets or natural food objects into the deep gravel or sandy floor surface of the day cage in order that the animals can spend many hours of the day digging and hunting for food. In this way an element of uncertainty and variety can be introduced into the daily life of the animal. Higher primates need, above all, intellectual employment and the stimulation of unusual objects or events.

The principal aim of the research will be to obtain measurements of tolerance of monkeys to captive conditions in laboratories, zoos, and in "free-ranging" captivity. The following aspects of tolerance should be considered:

1. Climatic: Response to high and low temperatures and humidity levels; habitus changes associated with different climatic conditions.

2. Physical Environment: Responses to altered environmental situations demanding changes in locomotor habits, resting habits, spacing behavior, sexual behavior, aggressive behavior, etc.

3. Dietetic: Responses to wide range of food and feeding patterns, with particular reference to changes in the skeleton.

4. Social Organization: Study of ideal group size in differing captivity situations and its relation to cage size.

5. Diversionary: Investigation of the value of "spare time" activities in the general welfare of the captive.

An essential correlate of this program will be a field investigation of certain basic behaviors of primates in the wild, e.g., diet, locomotion, climatic tolerance, resting posture, etc. (see "Field Studies" below). Captivity studies are clearly a long-term project that will be based both in the United States and the United Kingdom. Informal talks already have been held with a pharmaceutical research center in England that is interested in the possibility of setting up primate research of this general nature on its estates in the South Midlands.

FIELD STUDIES.—Field studies of free-ranging primates are pivotal to the systematics, captivity, and population studies discussed above, and they will constitute an important part of the program.

It is hoped that it will be possible to establish junior and senior field-study studentships for graduate as well as post-doctoral scientists. Senior studentships normally would be held for five years and the junior appointment for three years. This period will ensure that the post-doctoral worker will, on the completion of his field work, be available to contribute to the systematics and captivity research projects and to the teaching and other activities of the Primate Biology Program. A policy might be adopted whereby the holders of these two studentships would act as senior and junior members of a field-research team.

The possibility of establishing a field primate research training program at the Smithsonian Tropical Research Institute, Barro Colorado Island, Panama, in connection with the award of the junior field-study studentship will be investigated.

FUNCTIONAL ANATOMY.—Collection of data on sound biometric principles is still an important part of primate biology. There is no better example of this type of work than that provided by Adolph Schultz, whose lifetime study of growth and variability in the skeletons of higher primates has contributed so much to our knowledge. Statistical techniques such as that of multivariate analysis will in the future provide an even better method of assessment of such data; furthermore, it is expected, as a fall-out from such projects as systematics research, that new information on the anatomy and physiology of primates will become available. The field of primate anatomy has

been developed industriously for the past hundred years by authorities too numerous to mention. A synthesis of a century's work is admirably recorded in the monumental treatises of Dr. W. C. Osman Hill of the Yerkes Regional Primate Center. The physiological, or functional, anatomy of primates has attracted less attention. Because of its relevance for primate behavior, the anatomical and physiological whys and wherefores will rate special attention. The "new" science of Lorenzian ethology, in particular, seems to the writer to require an injection of what Elliot-Smith called the "illumination of comparative anatomy"; it is somewhat paradoxical to study the evolutionary significance of facial expression in primates, for instance, without a detailed understanding of the function of their facial musculature.

Over the years a number of projects in functional anatomy have occurred to the writer and are listed below. These are random ideas and are in no sense a definitive list of research proposals.

1. Significance of cheek pouches in primates.
2. Phylogeny and physiology of sexual swelling.
3. Anatomy, social significance, distribution, and phylogeny of sexual dimorphorism.
4. Adaptive significance of the bulla tympanica.
5. The relationship of the fat pad under the heel of primates to ecological adaptation.
6. The anatomy and behavioral significance of swimming in primates.
7. The functions of the primate tail.
8. Adaptations of the vertebral column in relation to primate locomotor patterns.
9. Adaptations of the nails and their phylogenetic significance.
10. The carriage of infants in relation to the locomotion of primates.
11. The functional morphology of ischial callosities.
12. The neonatal coat color; its significance in natural selection.

Education Program

In the earlier part of this paper considerable emphasis has been laid on the multidisciplinary approach of primate biology and on the need of its students to acquire a versatile attitude of mind. Primate biologists, for instance, who possess a working knowledge of systematics are to be preferred to systematicists who have a working knowledge of primates, for the systematics of primates should be based on the sum total of their biology, past and present.

The greatest deterrent to subject-oriented research in primate biology is, undoubtedly, the lack of primate biologists. The Smithsonian will not only supply grist for its own mill, but also it will provide a service for other museums and research institutions by developing an education program in this field.

Cooperative Graduate Programs: It is anticipated that the Smithsonian will be seeking education agreements for cooperative graduate

programs with certain universities in special relation to centers of primate research. Schemes of this nature would involve praticipation by staff specialists in lectures and seminars held at the graduate school in question and the admission of graduate students to internships at the Smithsonian for a period of a year or less under the supervision of staff members.

Crash Courses: Short and intensive courses on the principles of primate biology will be arranged for institutions and research centers for the benefit of professional employees and technicians.

Undergraduate Courses: Lectures and seminars will be arranged under educational agreements with universities in association with anthropology and zoology degree courses. In order to implement such educational agreements, the permanent professional staff, term appointees, graduate students, and consultants in specialist fields would be expected to play a professorial as well as a research role. Although the academic level of the different courses will vary with the status of students concerned and with the nature of their scholastic background, the subject content will be fairly constant and will embrace the following fields of study:

Principles of evolution, systematics, classification and evolution of primates. Zoogeography and ecology. Anatomy, physiology and behavior with particular reference to habitat (anatomical and ecological basis of behavior). Molecular biology and genetics. Zoonoses, welfare and husbandry of the captive primate. Conservation.

Courses will comprise some lectures but principally seminars and practical classes. Motion picture film will be used extensively (see "Film Library" p. 26). An essential corollary of a teaching program is the production of a comprehensive textbook. This obviously cannot be conjured up overnight and it may be several years before a satisfactory student manual can be produced. As an interim measure, the author is preparing a short student text that should be available, modestly priced, in 1969.

Collection Programs

The nature of the program outlined above will necessitate, above all, large and adequately cataloged study collections of primate skins, skulls, skeletons, and wet specimens.

Data Processing: Participation in the Automatic Data-Processing System for cataloging and retrieving information relating to specimens, a system already in use in the Museum of Natural History, is a possibility to be investigated. It is questionable whether the size of the present collection of Primates in the Division of Mammals would justify the high cost involved. Considered in terms of the international orientation of this program, however, such a partici-

pation would seem highly desirable; accordingly, the Primate Biology Program will consider the feasibility of processing data relating to primate collections in the major museums of the world. A project of this sort would be inconceivable for such organizational units as the Department of Invertebrate Zoology or the Division of Ornithology, but for the Primate Biology Program, which is concerned with relatively fewer species, a world-wide catalog is not out of the question. Such a catalog housed in one institution would be of immense value to primatologists.

Augmentation of Collection: Few museums possess sufficient duplicate material to allow synoptic loan-kits of skulls and postcranial bones to be made available to accredited institutions or to permit wet specimens to be dissected by graduate students; yet, such facilities would form an important part of an education program. Efforts will be made to augment the Smithsonian's already extensive collections by various means so that the following services can be implemented:

1. Specimens for Dissection: At present there is no adequate collection of embalmed specimens suitable for detailed anatomical dissection. Many requests for such material reach the Smithsonian annually. In the course of building up systematic reference collections, stocks of properly preserved anatomical material should be developed. These stocks would serve as a "bank" from which specimens could be drawn for study.

2. Whole Specimens for Loan: It is proposed to build up a "library" of the common varieties of primates. The animals preserved in their entirety would be stored in polythene envelopes without fluid and would be available for loan to scientific institutions.

3. Synoptic Osteological Collections: For temporary loan to primate centers and other scientific institutions.

4. Film Library: For certain fields of study, motion pictures are the essential correlate of more formal methods of instruction; for example, in primate biology, with its emphasis on behavior, films should comprise a major part of the course. It is not easy with large classes to demonstrate behavioral experiments on primates in the laboratory, but the identical experiments can be presented to any number of students simultaneously through motion pictures. Ecological and behavioral studies in the wild are assuming great importance in primate biology and naturally constitute a major part of student instruction; it is clearly impossible to transpose a group of students to the rain forest but perfectly feasible to bring the rain forest to them—on film. Locomotion studies are pivotal to the understanding of primate biology for the primate is structurally a locomotor machine. Locomotion can be illustrated theoretically in a biomechanical diagram of forces, but its behavioral significance, in relation to feeding, etc., can be understood only in dynamic terms where posture, movement, and environment are brought together in one demonstration. It is proposed to develop a library service lending films to laboratories and university departments for educational use. This is substantially the procedure that is followed at the present in the Smithsonian Unit of Primate Biology in London.

5. Identification Service: The existing collections of the Division of Mammals would make it possible to provide an identification service for outside organizations.

6. Identification Manual: There would appear to be an urgent need in many laboratories that use for a short and concise identification manual; preparations for such a publication are already underway. The manual would incorporate a number of color plates of the skins of certain common laboratory primates.

Postscript

A long time has elapsed since 130 A.D., when the anatomist Galen of Pergamum, discovering that, of all living things, the ape is "likest to man," proceeded to practice what he preached by using monkeys as substitutes for human cadavers. Eighteen centuries later—although the correctness of Galen's pronouncement has long since been proven up to the hilt—we are still somewhat chary of admitting the full potential of this relationship.

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